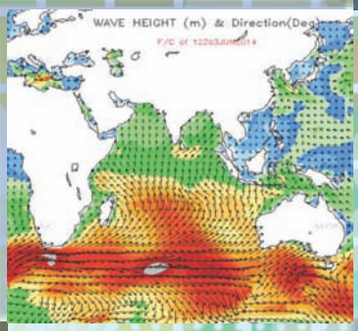
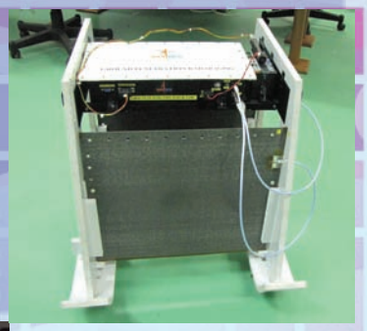
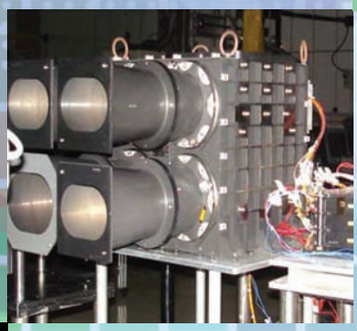
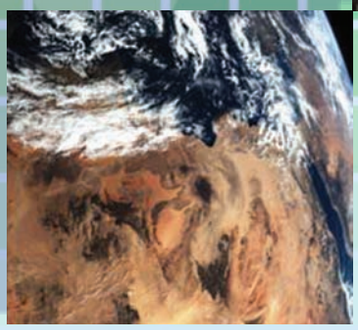
ANNUAL REPORT
2013 - 2014









SPACE APPLICATIONS CENTRE

INDIAN SPACE RESEARCH ORGANISATION,

AHMEDABAD - 380 015.

Director's Preface

SAC is playing a lead role in the Application driven Indian Space Program. Country is witnessing large demand of satellite based services in all walks of life. Communication & Navigation applications are increasing exponentially and are limited by only an individual's imagination. GIS based services are becoming an essential part of administration services of country. More and more departments are coming forward for using satellite based services. Satellite data is increasingly being used in study of forests, oceans, glaciers & climate change.

SAC is striving hard to fulfill the requirement of the Country's demand in communication. GSAT-16 payload which was flagged off on January 7, 2014 has successfully completed all spacecraft level tests and has been launched in December 2014. Payloads for GSAT-9, GSAT-15 are in advanced stage of realization. In addition to this, various payload development works are going on for GSAT 7A, GSAT-11, GSAT-17, GSAT-18 and GSAT-19. SAC is also developing a high power communication payload GSAT 20 satellite for mobile communication. Development of Satcom Terminal for Mobile Satellite Systems is also progressing well in the centre.

Considering the congestion & scarcity of the spectrum, SAC has already started R&D activities for higher operating frequencies from Ka, Q, V, W to optical bands with flexibility in coverage, bandwidth and power.

The need for positioning based services has tremendously increased for civilian as well as strategic usage. In order to meet this high demand, Indian navigation satellite system IRNSS is getting established to provide accurate positioning with fast update rate for land/sea/air based users.

During this year IRNSS-1C payload was delivered on March 28, 2014 and satellite was launched in October, 2014. Other payloads in this series will also be delivered in quick succession. GAGAN payload on GSAT-15 will strengthen our existing Space based navigation systems. SAC is taking strides in the developments of receiver systems which can support our own IRNSS as well as other global navigation system.

SAC is playing a very important role in the Remote Sensing, Meteorology, Scientific and planetary programmes of ISRO. Payload development for Resourcesat-2A, INSAT-3DR and Chandrayan-2 is in an advanced stage. Developments related to Cartosat-2C, GISAT, ASTROSAT and a solar observation satellite, ADITYA-1, are under progress. We are going to enter the Mars orbit on September 24, 2014. This will start a new chapter in Indian Space Program.

Design & Development for Radar Payloads of RISAT-1A, RISAT-3 (L Band) and Ku-band Scatterometer is progressing well. Recently, under international cooperation, S-Band SAR configuration of NISAR has been finalised. This is the acknowledgement of SAC/ISRO & India's capability in developing complex space technologies.

In the area of remote sensing applications, SAC has made pioneering contributions in the field of agriculture, forestry, coastal zone management, fisheries, urban planning, watershed development, ground water prospecting, snow & glacier studies, oceanography and atmospheric studies. Preparation of snow cover maps for 30 basins and Mass balance estimation of glaciers for 2012 for 10 basins were completed on March 27, 2014.

INSAT-3D IMAGER and SOUNDER data processing and the products are routinely generated at MOSDAC and IMDPS at India Met. Department. INSAT-3D Meteorological Data processing System (IMDPS) was dedicated to Nation at National Satellite Meteorological Centre, IMD, New Delhi by Honorable Minister of Science & Technology, and Earth Sciences in January 2014.

All the products & processes developed and followed at SAC are subject to stringent quality standards. SAC has taken firm steps towards Total Quality Management (TQM) by introducing Mechanical material, part and Product Data Management Systems (PDMS) for traceability.

Indigenization of critical components and new process development activities in the areas of Electronic & Mechanical Services has been taken up to cater to the need of future payloads requirements. 26 new processes are developed in house and 22 new processes are under development or optimization under electronic and mechanical services. SAC has commissioned Low Temperature Co-fired Ceramic (LTCC) fabrication facilities as a part of advance packaging technology and all the process parameters are optimized. This will be the first space qualified LTCC facility in India. Establishment of 5 Ton shaker is an important augmentation in SAC facilities.

Project and research activities are efficiently planned and managed in the centre. SAC has carried out more than 150 in-house Technology development projects and 40 RESPOND program with academia. 5 MOUs with industries and 4 with Academic Institution including IIT- Gandhinagar and NID, Ahmedabad have been signed during the year. Software developed by mechanical facilities “e-SMART” is proposed for technology transfer.

During the year many training programmes, workshops and lectures were organized to update and improve the knowledge of all employees to achieve personnel and organization goals.

Centre has also established infrastructure in the campus. New labs are established for Plane Polar Near Field (PPNF), New Co-Ordinate Measuring Machine, Cal-Val sites. Renovation of Guest House with new utility equipments has been completed. Civil work of Payload Integration Lab at Bopal Campus has been initiated in all earnest. Solar energy usage in the centre has significantly increased.

SAC fraternity is actively participating and contributing in the “Vigilance Awareness Week", “Safety Week”, Blood Donation camps etc. During recent Blood Donation Drive 190 blood bottles was given by SAC, DECU & CISF employees and even by some support service personnel.

Administration, Accounts and Purchase & Stores have aptly supported the technical activities and they are playing important role in the Centre's overall activities. A considerable work has been done in the “Raj Bhasa” Hindi activities and many of our colleagues have received appreciation for them.

A. S. Kiran Kumar

SAC Management Council (SMC) As on March 31, 2014

Shri. A. S. Kiran Kumar, Director, SAC & Chairman, SMC

Shri.V. S. Palsule, Director, DECU

Smt. Mallika Mahajan, Controller, SAC

Shri.D. K. Das, DD, SNPA

Dr. J. S. Parihar, DD, EPSA

Shri.Santanu Chowdhury, DD, SIPA

Shri. Saji A Kuriakose, DD, SEDA

Shri.Tapan Misra, DD, MRSA

Shri. R. K. Arora, DD, ESSA

Shri. R. M.Parmar, DD, SRA

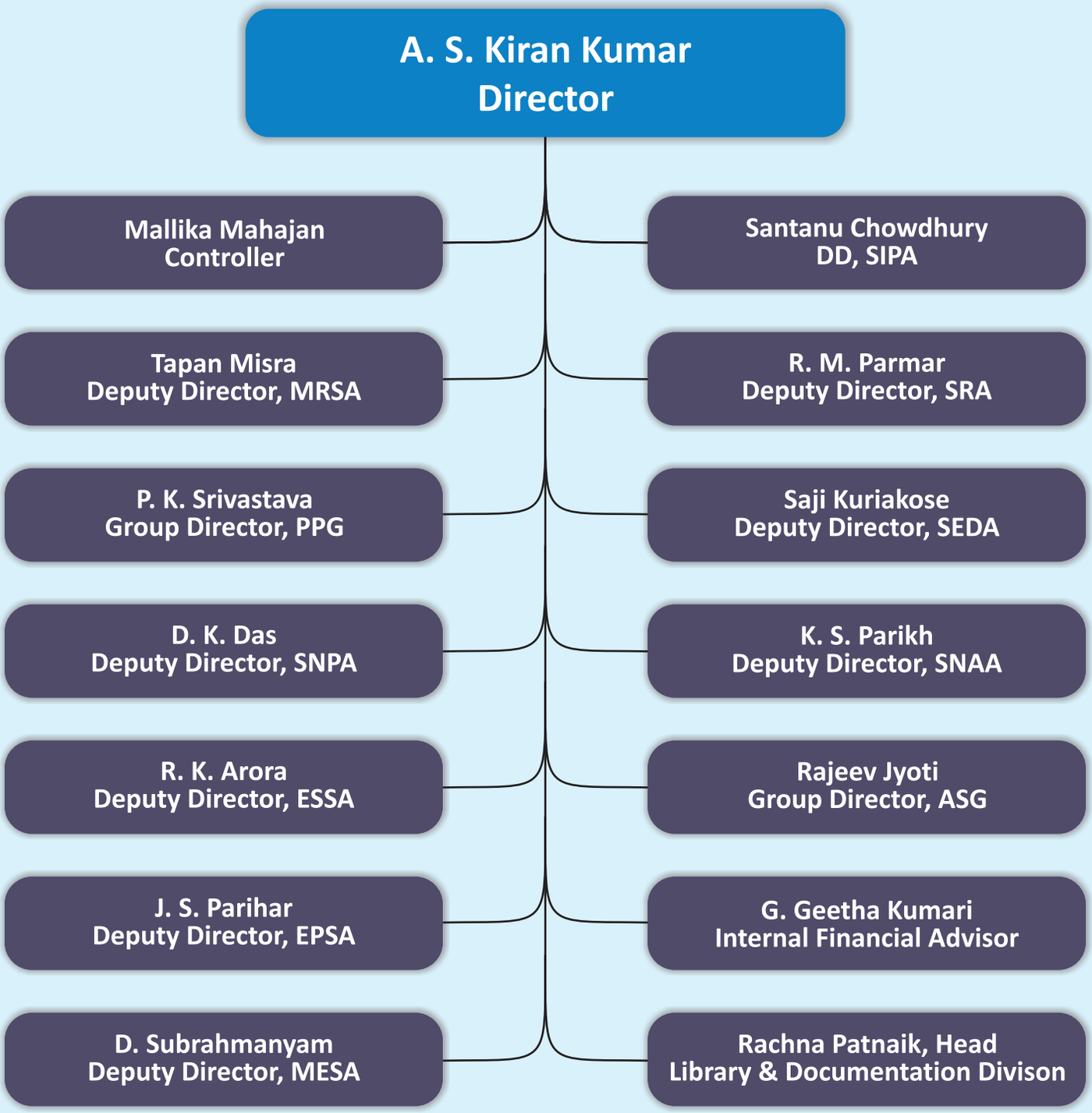
Shri. D. Subrahmanyam, DD, MESA

Shri. K. S. Parikh, DD, SNAA

Dr.P.K. Srivastava, GD, PPG & Member Secretary, SMC

SAC ORGANISATION

As on March 31, 2014



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SPACE APPLICATIONS CENTRE

Space Applications Centre (SAC) is a unique centre dealing with a wide variety of themes from payload developments to societal applications, thereby creating a synergy of technology, science and societal applications. The centre is responsible for the development, realization and qualification of Communication, Navigation, Earth observation and Planetary payloads and related data processing and ground systems in the areas of communications, broadcasting, remote sensing, disaster monitoring/mitigation, etc. It is playing an important role in harnessing space technologies for a wide variety of applications for societal benefits. In order to carry out the above tasks, SAC has highly sophisticated payload integration laboratories, electronic and mechanical fabrication facilities, environmental test facilities, systems reliability/assurance group, image processing and analysis facilities, project management support group and a well-stocked library. SAC has also put adequate emphasis on and practicing outsourcing and indigenous development of technology and vendors.

Activities at SAC are organized into following Areas

- SATCOM and Navigation Payload Area (SNPA)
- SATCOM and Navigation Applications Area (SNAA)
- Sensor Development Area (SEDA)
- Microwave Remote Sensors Area (MRSA)
- Signal and Image Processing Area (SIPA)
- Earth, Ocean, Atmosphere, Planetary Sciences and Applications Area (EPSA)
- Electronic Support Service Area (ESSA)
- Mechanical Engineering Systems Area (MESA)
- Systems Reliability Area (SRA)
- Antenna Systems Group (ASG)
- Planning and Projects Group (PPG)
- Library
- Administration & Auxiliaray services

SATCOM & SATNAV Payload Developments and Applications

SAC is responsible for delivering the payloads for all spacecraft providing Communications and Navigational Services, most notably the GEOSAT and IRNSS programs.

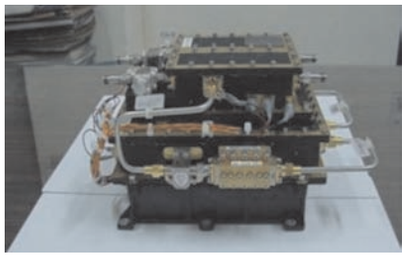
The year 2013-14 saw the successful In Orbit Testing (IOT) and commissioning of communication payloads for GSAT-7, GSAT-14, IRNSS-1A & 1B, and INSAT-3D. Payloads for GSAT-16 and IRNSS 1C were delivered to their projects in 2013-14, followed by IRNSS-1D which was delivered in July 2014.

Development of various Subsystems for GSAT-9, GSAT-11, GSAT-15, GSAT-17, GSAT-18 & GISAT are in progress.

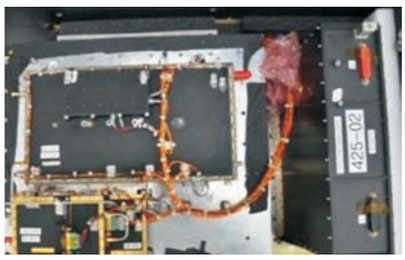
GSAT-7

GSAT-7 was launched on July 26, 2013. It has 11 transponders in C-band, Ku-band and CxUHF UHFxUHF, and SxC bands. It is designed to provide communication capabilities to special users over a wide oceanic region including the Indian land-mass. It hosts a number of new technologies that were specially developed for the new critical applications.

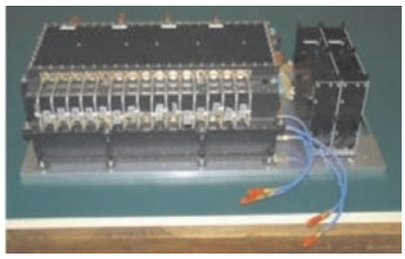
Payload characterization of all main configurations and antenna pattern measurement was completed and Payload performance was satisfactory. The end users have been using the system successfully for nearly a year.



Ku-band Up-down Converter (QM)



100 Watt UHF SSPA

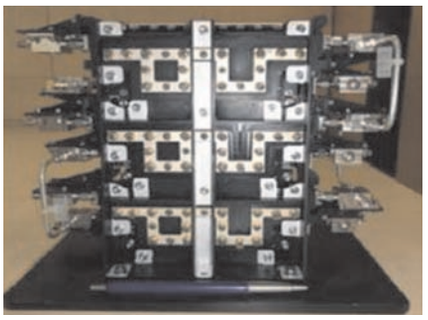


Analog Mesh Processor

GSAT-14

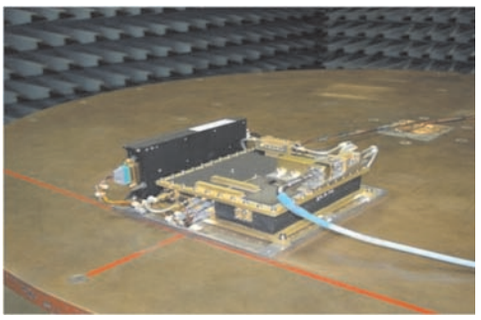
GSAT-14, has Six extended C-band transponders, Six Ku-band transponders and Two Ka-band Beacons was launched from SDSC, SHAR on January 5, 2014 by GSLV-D5.

In-orbit test (IOT) of all transponders including Antenna Pattern measurement and Power stability tests was completed and Payload performance was found to be satisfactory. EIRP measurement of 30.5 GHz beacon completed at AES-SAC. Results were matching closely with the expected data. The IOT was also an opportunity to demonstrate a new method of in-orbit characterization of operational transponder channels.



Upper Ext. C-Band 6- Ch. DR IMUX

30 GHz Beacon



20 GHz Beacon

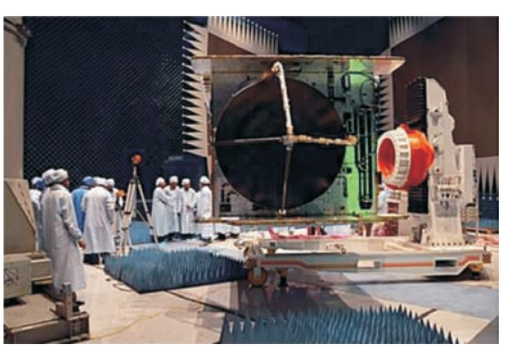
GSAT-16

GSAT-16 is having the largest payload till date from ISRO. Wherein 48 transponders (24 C-Nor band, 12 C-Ext band, 12 Ku band and beacon) are accommodated in I-3K class Bus. Payload was delivered from SAC on January 07, 2014 after completing integrating payload level radiation test.

T&E of 12-CH C-band DR OMUX , 6-CH C upper_ext-band DR OMUX, C nor-band HRF, Cupper_ext-HRF , C-band Tx-Tx & Rx-Rx Diplexer , C-band Tx & Rx Couplers , IMUX NOR-C (GCP-08) and EXT-C (GCP-27) & C-band 6 Ch. Output Multiplexers were completed. Characterization of Integrated Payload in Disassembled mode for Nor-C & Ext-C Band (Total 36 transponders) was completed.

During this year Flight Model C-band DGR antenna of GSAT-16 & feeds were indigenously developed and successful evaluated by Test & Evaluation. Ku-DGR antenna which is being fabricated at M/s Astrium, has completed major milestones for which RF analysis were carried out at various stages like fabricated surface analysis with proposed best fitted surface cases and TED analysis etc. One important major change implemented in GSAT-16 communication payload is EMI/EMC test on payload integrated on spacecraft mock up along with feeds and antennas. This was carried out in CATF for the first time. 1.4m prime focal C-Rx/Rx shaped reflector antenna has undergone through rigorous testing and subsequently RF analysis to diagnose the problem of cross polarization deterioration.

The Payload was delivered from SAC on January 07, 2014 after completing T&E. Spacecraft level tests are in progress at ISITE Bangalore.



Radiated mode tests at CATF

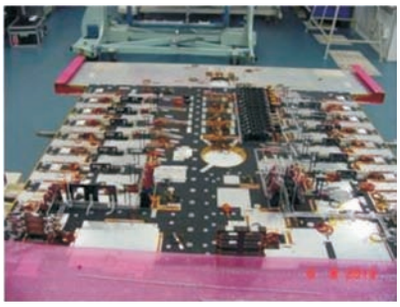
MMIC Based ALC Driver Amplifier

GSAT-15

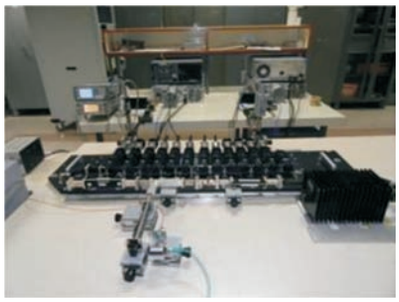
GSAT-15 comparises of 24 Channel High Power Ku Band FSS transponders and GAGAN payloads. During the year, significant work has been carried out on various subsystems.

PDR of Ku Band Driver Amplifier was completed. T&E of Ku Beacon SSPA was completed. EV panel layouts (Top and Underside) finalized & sent to ISAC. EV panel received for payload integration. Payload harness is in progress. Structural analysis of EPC for L-Band SSPA completed. Analysis of T&E results of various sub-systems is under progress. Testing and optimization of L5 up converter FM1 & FM2 and electro-Mechanical Compatibility of Power Amplifier package of L-Band 40W SSPA, QM of GAGAN payload was completed.

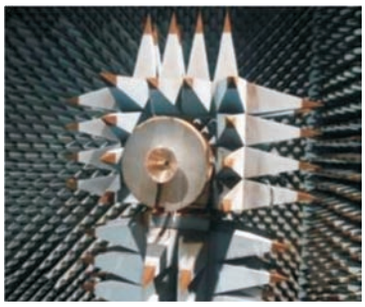
DVM of Helix array with square co-axial feed network was realized and gain improvement of 1.0 to 1.2 dB was achieved at different frequencies.



GSAT-15 Ku-Band 13 Ch OMUX PIMP Test Setup



GSAT-15 South Panel Under Assembly



Ku-Tx Horn Antenna

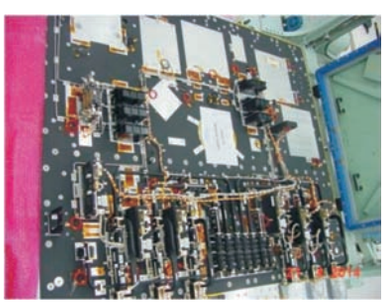
GSAT- 6

GSAT-6 is a multimedia mobile GEO satellite, providing BSS and MSS services. Since, the payload has been stored at ISAC for more than three years, details of re-testing and switch ON sequence are critically addressed. Revalidation of 6 FM units of 230W S-band LTWTA completed. All S-band LTWTAs re-integrated at ISITE, Bangalore after revalidation at SAC. EV Panel payload packages integrated on the dummy EV panel for AIT activities at ISITE/ISAC, Bangalore. Successful T & E of 0.8m C-band Transmit / Receive Antenna catering to Indian Mainland was completed. Antenna was delivered to ISAC for integration with spacecraft.

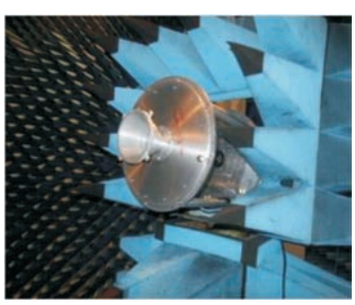
GSAT-9

The payload comprises of 12 Ku Band transponders to enhance Ku-band services for DTH. The Ku-band payload has 2.2mx2m offset single shell shaped deployable Tx/Tx Reflector antenna and 1.4 m dia. offset single shell shaped deployable Rx/Rx Reflector antenna to provide service over India mainland and Andaman and Nicobar Island from location 48°E longitude in dual linear polarization.

All Payload subsystems are ready. North & South panel payload integration on dummy panel was completed. Open mode checks for both panels were completed. Final Assembly of Ku-Rx Feed Antenna system was completed and FM North panel was received for payload integration. High power Multipaction test for Ku-Band OMT (QM & FM) in TVAC condition was completed. 12 units of Ku Band Driver Amplifiers is under T&E.



North Panel under Assembly



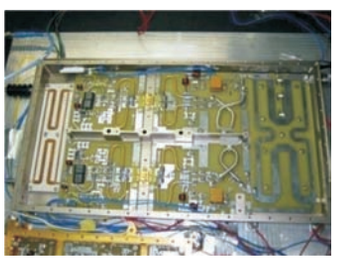
Ku Tx Feed Horn

GSAT-11

GSAT-11 is an advanced communication satellite employing a new class of bus weighing 4000-6000 Kg. The communication payload includes Ka x Ku-Band Forward Link Transponders and Ku x Ka band Return Link Transponders. The payload architecture with high gain spot beams groups managed by Gateways and star networks will extend the reach of Indian broadband infrastructure to households, education institutions, business etc.

High Throughput Payloads

Mechanical Package design of Ku X Ka, Ka X Ku converters & Tracking LO were completed. Full integration of Ku Upper IMUX (2 FM units) was completed. Mechanical design of integrated filter packages for lower frequency band (10.7 to 11.7 Ghz) and for higher frequency band (12.7 to 13.3 GHz) was completed. DVM for all Ku and Ka band LNAs, Convertors, Los, Channel Amplifiers, Ku and Ka band Beacons completed. North & South Panel layouts finalization is in progress.



100 W UHF SSPA

GSAT-11 DVM antennas are successfully realized during this year and QM antennas are under final stages of assembly. The achievement of these antenna development include a) excellent performance of multihole tracking coupler and communication cum tracking feed, b) compact novel Ortho-Mode-Transducer (OMT) with very good port to port isolation and low insertion loss, c) wideband Ka-band OMT and d) Ka-Tx/Rx Diplexers.

GSAT-7A

GSAT-7A payload will provide communication capability to the special user in Ku-band over Indian land mass, islands and surrounding regions.

Tentative North & South & EV panel layout worked out as per modified configuration. 6 channel Ku band OMUX (1FM and 1QM) and 5 channel Ku band OMUX (1FM) are under mechanical fabrication.

GSAT-7A antennas have undergone through the cycle of requirement changes and post CDR new antenna configuration was worked out with new technological elements a) Gregorian Shaped Reflector Antenna, b) Steerable Shaped Reflector antennas with centralized mast for feeds. The antenna was designed with sharp roll-off beyond the coverage area and very good Cross Pole Isolation i.e. <-32 dB.

GSAT-17

Spacecraft & Payload configurations are being worked out. Antenna requirements / realization plan & status are studied. System as well as subsystem level performance specifications finalized. Preliminary North & South panel layouts were worked out.

GSAT-18

System as well as subsystem level performance specifications finalized. Payload telemetry, tele-command, power and weight estimates generated.

GSAT-19

Payload configuration along with proposed additional payloads in Q-band and Optical band presented to project in Spacecraft review at ISAC Bangalore.

GSAT-20(S-band Mobile Satellite)

Payload configuration options worked out and presented before GPMC at ISAC, Bangalore.

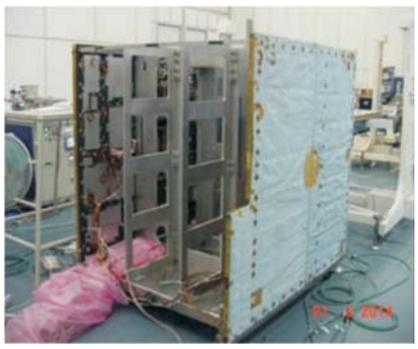
IRNSS

IRNSS- 1B payload was flagged off on March 31, 2013 after successful Test & Evaluation. Spacecraft level thermovacuum tests and CATF test was completed successfully at ISITE Bangalore. Pre Launch Tests completed successfully at SDSC SHAR. Payload was launched on April 4, 2014 from Sriharikota.

Test and Evaluation of Integrated Payload of IRNSS-1C was completed successfully and the payload was flagged off on March 28, 2014. Subsytem development of IRNSS-1D is in final stage. North & South FM panels were received for payload integration.

Antennas for IRNSS-1B and 1C are delivered to the project and realizations of antennas for 1D are under progress.

IRNSS-1C Payload Flagged off by Shri A S Kiran Kumar, Director, SAC on March 28, 2014



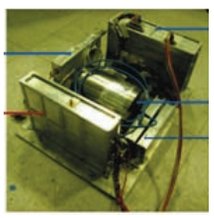
IRNSS-1C : Tri-Panel Integration

C-TX horn antenna

IRNSS Critical Technologies

Rubidium Atomic Clock Development

Rb Atomic Clock was developed with SAC made Physics Package using imported bulb and cell (DVM 2). Indigenous Atomic Clock Management Unit (ACMU) was integrated & tested with Rubidium Atomic Frequency Standard (RAFS).



Indigenous Rubidium Atomic Clock

Other SATCOM/SATNAV Projects /Applications

GSAT-11: Ground system development

Integration of Digital Monopulse Tracking Receiver module and CoreBRT (Mil 1553 Remote terminal IP core) were completed. Acceptance testing of the redundant Block up & down converter systems was completed.

GSAT-6: Terminal development

Four types of terminals have been developed under GSAT-6 MSS application project. Reporting Terminal (RT); is a battery operated Hand held terminal with in-built GPS receiver working in S-band. It is capable of 1.2 Kbps data rate transmission with Aloha and TDMA protocol for position reporting service, short message communication and sensor data reporting. Ten terminals have been fabricated by industry, based on technology developed in SAC. These terminals are tested in RF loopback and through INSAT-3C with higher gain antenna.

Broadcast Receiver (BR); This terminal is an important element of overall GSAT-6 applications. This is a DVB-S based broadcast receiver, developed to support reception of multichannel audio, video and data from 1.024 MSPS to 5.5 MSPS (selectable from 1024/2048/4096/5500 KSPS). The receiver has been realized after integration at sub-module level and tested with standard DVB-S transmission. The functional verification has been completed successfully. The design of integrated unit is in progress and the integrated terminal with package will be ready by November 2014.

Satellite Mobile Radio (SMR); This is a handheld terminal to support two way voice and small message communication between terminals and between terminal and other telecom networks (PSTN & Mobile). It uses PAMA & DAMA channel access scheme. Breadboard model of SMR is completed and tested in RF loop back using communication channel unit for voice communication using PAMA mode. Based on SAC design, five units are under manufacture at industry. Firmware development is in progress and delivery is expected by December 2014.

Portable Multimedia Terminal (PMT); Portable Multimedia Terminal provides two-way IP data connectivity at 144 Kbps to primarily support video conferencing applications. Breadboard model of PMT has been completed. Based on SAC design, five units are being manufactured at industry. Firmware development to support new IP enabled HUB is in progress. Five terminals will be ready by December 2014.

Broadcast Receiver

Satellite Mobile Radio (SMR)

Portable Multimedia Terminal (PMT)

GSAT-6: HUB Base band systems Development

SAC has developed Multi-beam IP based HUB for Reporting, Voice, Multimedia and Broadcast services.

Reporting Service

Reporting Service Hub Baseband system provides real time storage and forwarding of received data, from reporting terminals to different user agencies via Email, FTP and HTTP. The system consists of physical servers, running on Linux environment, mapped to logical servers namely Network Control Processor (NCP), Network Management System (NMS), Data forwarding application server, Database server, Email server, FTP server and GIS server. Development of the system was completed and demonstrated the Reporting service in satellite link.

Burst demodulator

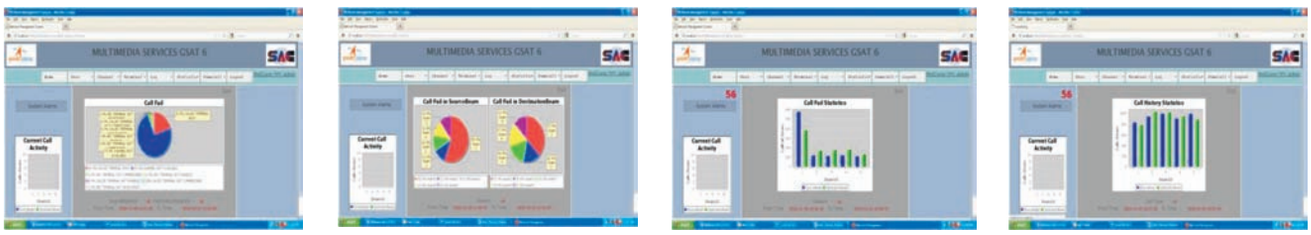
Burst demodulator support 24 x 7 operation with an operation frequency of 950 to 1750Mhz. Successfully tested in RF loop back and through satellite for reporting service using INSAT-3C.

Broadcast service

Broadcast service aims at HUB using DVB-S/S2 transmit system. It provides all functions of the re-multiplexing of services and components, querying the structure of transport streams, SI extraction, table cycling, adaptation of PIDs, services, tables and descriptors. DVB-S/S2 broadcast chain using IP/MPEG receiver at IF Level with different combination of multiple A/V channels (16 and 32) at different rates was tested.

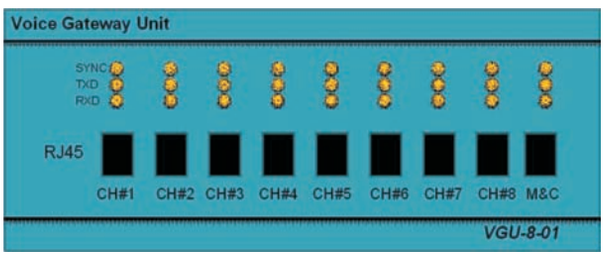
Portable Multimedia Service

Multimedia services for GSAT-6 provide video conferencing between terminals & between terminals and Hub.Development was completed and validation carried out using TGA to simulate call generation. Integration with terminals is in progress.



Multi-media service HUB GUI

Satellite Mobile Radio service



8-channel Voice Gateway Unit

All three types of communications are possible – terminal to terminal, terminal to PSTN and PSTN to terminal. The routing of media packets are done at IP level using IP managed switches or routes. The routing is managed by Network Control Processor (NCP). The NMS performs network management & control function in the system. It includes commissioning of terminal, online network monitoring, channel assignment, beam switching and accounting of system usage and billing.

NCP & NMS are tested and verified with traffic emulator. The single channel Voice Gateway Unit for external network (GSM/PSTN) interface were developed and demonstrated. Development of 8-channel VGU is under progress.

GSAT-6 Hub RF sub-system

Augmentation of present MSS type-D Hub RF system at AES for initial testing of GSAT-6 satellite and application demonstration was carried out.

IRNSS: User Receiver & Ground Segment

IRNSS SPS-GPS- user Receiver

Implementation of integrated read module for control parameters and navigation data for the simulator was completed and testing with single channel SPS/RS Receiver for all seven PRN codes for both SPS and RS was completed. Development of Key generation software for generation of random keys for encryption was completed and installed at MCF, Hassan. The encryption of long codes using the AES algorithm on FPGA has been completed. Development of automated software for reaching the appropriate code phase of the long code generator was initiated. All variants of SPS Receivers like IRNSS SPS, GPS, and Hybrid are implemented on Kintex-7 platform. 14 channel (12 GPS + 2 IRNSS) SPS receiver was tested with live IRNSS grid correction on GPS solution. In-house development of carrier NCO & interface of carrier phase values with PR module was completed. APTR-IOT of Payload Test Receiver delivered at MCF Hassan and used for the IOT of IRNSS 1A satellite. APTR 2nd unit was installed at AES for receiving and recording IRNSS -1A satellite signals. Two High Gain card with AGC of RF Front End tested at L5 and S band delivered to the project for INC User Receiver. Microstrip Quadrifilar Helix Antenna at L5 band using sequential rotation was developed.

GAGAN

GAGAN is a Satellite Based Augmentation System (SBAS) implemented jointly with Airport Authority of India (AAI), to provide Satellite-based Navigation services. The GAGAN signal is being broadcast through two Geostationary Earth Orbit (GEO) satellites - GSAT8 and GSAT10 - covering whole Indian Flight Information Region (FIR) and beyond. An on-orbit spare GAGAN transponder will be flown on GSAT-15. The Directorate General of Civil Aviation (DGCA), India has provisionally certified RNP0.1 (Required Navigation Performance, 0.1 Nautical Mile) service level to GAGAN System on December 30, 2013.

Operational Support

12 Nos. MSS Type-D terminals and WLL VSAT Terminal was given to IIRS Dehradun for Uttarakhand flood relief & DMS operations. All Terminals are operational. Five DMS nodes, employing 1.8 M VSAT antennae with 2/5 W SSPB were deployed at different locations of Uttarakhand.

Remote Sensing (Optics & MW) Payload Developments & Applications

SAC is responsible for the design, development and realization of optical remote sensing payloads for Earth observations, Meteorological applications, planetary missions and airborne applications. Currently SAC is involved in developing payloads for nine missions for low earth orbit (LEO), geostationary orbit (GEO) and a lunar mission. These include cartosat-2C/2D, Cartosat-3/3A/3B, Oceansat-3, Resourcesat-2A, INSAT-3DR&S, High resolution GEO (GISAT), Chandrayan-2 and Aditya-1

INSAT-3D

INSAT-3D is an advanced weather satellite of India configured with improved Imaging System and Atmospheric Sounder. INSAT-3D is designed for enhanced meteorological observations, monitoring of land and ocean surfaces, generating vertical profile of the atmosphere in terms of temperature and humidity for weather forecasting and disaster warning.

Spacecraft level dynamic tests were conducted successfully and Imager and Sounder performance was found normal after all tests. Exhaustive Shock tests were done on important subassemblies, as per transfer function derived from payload and spacecraft level hammer tests. Satellite was launched on July 26, 2013. INSAT-3D payloads were 'Switched ON' on 7th August, 2013. The data was received at Bopal Earth Station by DR (Data Reception) Systems developed in SEDA. Initial-Orbit-Tests (IOT) were conducted in two phases. Pre-post payload performance completed and compared with ground test observation. Antenna pattern cut measurements as part of IOT prior to Yaw-flip (with North Feed) and after Yaw-flip (with South Feed) were carried out at MCF, Hassan. Operation directives are generated for avoiding Earth Disk cut in image as and when required. Image based Servo Error computed and images (IMAGER) restored successfully. Installed and operationalized one CAMPES system for on-orbit (offline) data processing. System can be accessed remotely anywhere from SAC-NET for both IMAGER and SOUNDER payloads. Detailed analysis for Fast scan linearity with enabled and disabled mode were carried out for On-orbit INSAT-3D IMAGER payload. 7 Chains of Data Reception Systems established, these are operational at BES and IMD, N. Delhi. Analysis of Sounder and Imager data were carried with IMDPS team. Spectral response functions (SRFs) were compared for Imager and Sounder with GSICS radiances along with IMDPS team members.

INSAT-3D S/C on Ariane

INSAT-3D payloads

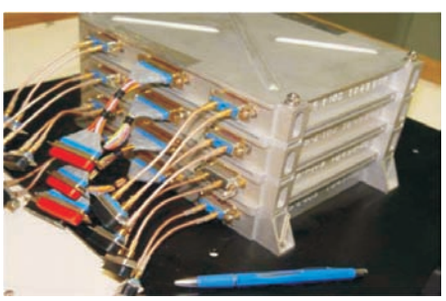
INSAT-3DR&S

INSAT-3DR is a follow on satellite of INSAT-3D. Payloads are expected to be delivered on next year. T & E of Imager attenuator package of pre-amplifier & Pre Amp test unit were completed. Component mounting and functional testing of Imager regulator card was completed. Functional testing of Imager detector card (DHA) completed. Development and testing of CAMPES software was operationalised at clean room Integration server. Imager telescope optical elements were assembled, aligned and payload integration was completed. Incoming inspection of both Imager and Sounder Coolers were completed. Dummy Decks were refurbished. T&E of Electrical Ground Support Systems were completed. Imager and Sounder EOM assembly and integration activities are completed. All subsystems are integrated. Filter wheel integration is completed.

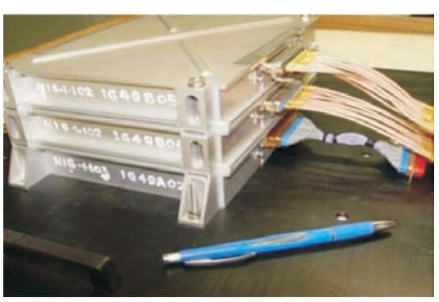
INSAT-3DR payloads

Filter wheel assembly

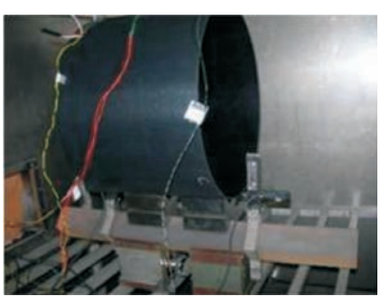
INSAT 3DS, the ground spare is a follow on of INSAT-3DR. T&E of Imager & Sounder Pre- amplifier packages were completed and 4 packages deposited in Bonded Stores. Functional test of 72 cards were completed. Visible DHA was integrated with EO Module and Post integration performance of Sounder was verified. EOM plates rework/lug machining were completed and ready for dispatch to ISAC for honeycomb fixing activities. CTE measurements of indigenously developed CFRP cylinder were carried out.



INSAT-3DS Imager Pre-Amplifiers



INSAT-3DS Sounder Pre-amplifier



CFRP cylinder

RESOURCESAT-2A

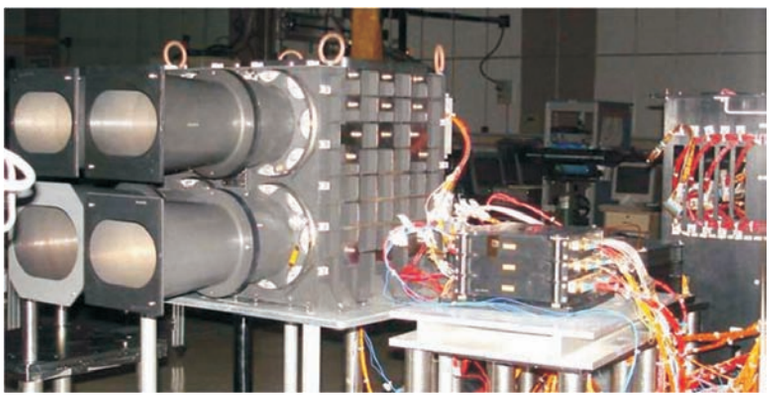
RESOURCESAT-2A is intended to continue the three-tier remote sensing data services to global users provided by RESOURCESAT-1/2.

Camera electronics for LISS-3*, AWiFS-A (VNIR) & AWiFS-B (VNIR) were completed for T&E. Structure of LISS-3* payload is thermal painted and delivered for final integration. All DHAs are integrated and T & E of the same was completed. Revalidation of integrated payload test setup of Liss-3 was carried out. Initial Bench Test, Thermo Vacuum Test, and Vibration test for FM DHA (B2, B3 & B4) as a part of T&E of Liss-3 was completed. LISS-3 (SWIR) DHA is ready for integration.

168 hours burn-in test of FM PLE-22 (T&E package) of AWiFS was completed. Vibration test of AWiFS-A- B2, B3 & AWiFS-B- B2, B3, B4 DHAs and five VNIR DHAs were completed. LISS-3 (VNIR) & LISS-4 DHA are under T&E. New 6K detector for AWiFS (SWIR) is under fabrication. Payload Integration has been initiated. Feasibility worked out to implement DPCM bypass by Tele-command as well as data compression for LISS-4 & LISS-3 (VNIR & SWIR).

All DHAs of Liss-4 are integrated and T&E of the same were completed. Validation of structure for deviations, observed in vacuum brazing for LISS-4, was verified and structure was cleared for FM integration. The components for stray light cover are under fabrication.

Liss 4 Structure



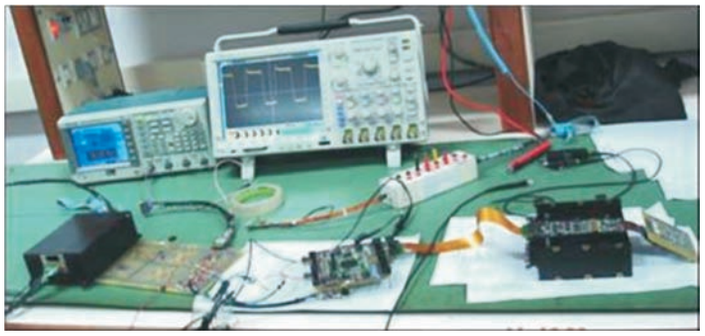
Liss 3 Camera EOM under evaluation

CARTOSAT-2C/2D

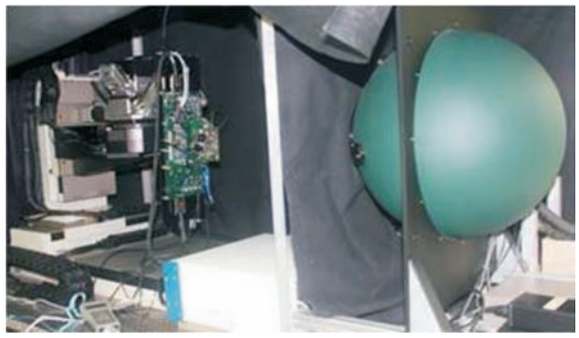
Cartosat 2C, the next payload in the Cartosat 2 series, will provide continuity of data services to the user community on operational basis. It has a spatial resolution of 0.63m PAN and 1.57m MX bands with an operational life of 5 years. Time Delay and Integration (TDI) detector with enhanced radiometric performance will ensure continuous imaging.

TDI mode of operation development of quad detectors was completed. Mounting & qualification of strip filters were completed. S/C Interfaces, P/L operating modes and Mechanical configuration was finalized. PAN EM detector up screening is in progress. MX Designs (CE) was completed and PRT is in progress. Event Monitor -1 (VM) fabrication is in progress. PCIe based DAQ was developed (5Gbps). PDR of structure (CMSE) was completed. VIT and Matrix mode discussed further with BDH w.r.t. interfaces. VIT mode and Matrix Mode incorporated in the MX logic design. PAN FPGA design as per present requirement is completed.

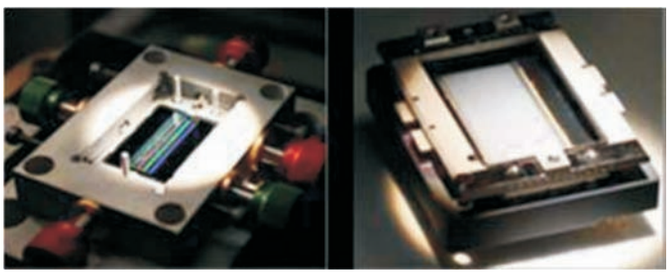
Standalone testing of Carto-2C MX Optical butting test setup completed. Completed design & development of Checkout Instruments and established Payload Evaluation Software for CARTO 2C MX Optical Butting Test Setup for MATRIX mode of operation and carried out the interface test successfully with the Camera Electronics hardware.



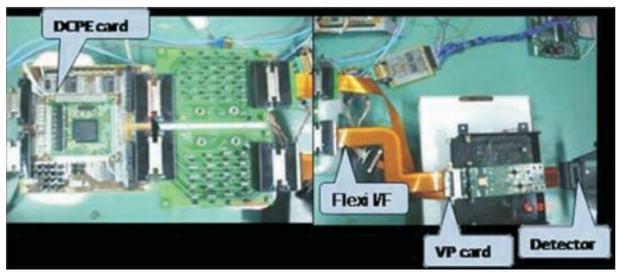
BBM FCE I/F with PSU



Detector characterization set-up



Filter mount assembly and detector mount assembly qualified

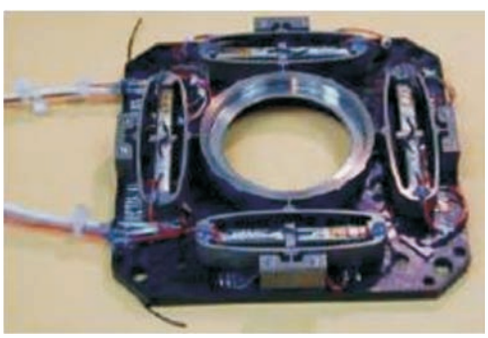


BBM MX CE Interface with detector

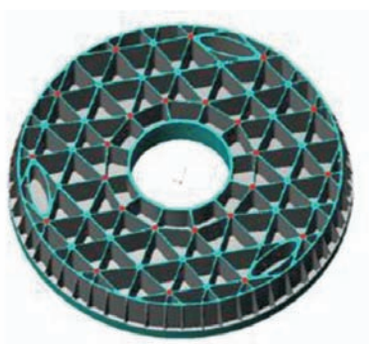
CARTOSAT-3

Cartosat-3 is an advanced version of Cartosat-2 series with improved spatial and spectral characteristics (0.25m PAN, 1m Mx, 5m MIR, 5-12m HYSI-VNIR & HYSI-SWIR).

Korsch type telescope design for 1.2m aperture, FOV 1°, 16m focal length for visible spectrum has been completed. In-house development of test bench, for carrying out electro-optical characterization of 2.6K and 1.3K TDI detectors, were completed. FM devices are received and screening is in progress. CE designs (PAN& MX) are available. Preliminary FCE configurations study was carried out to work out optimal interfaces like SerDes type BRC rate etc.

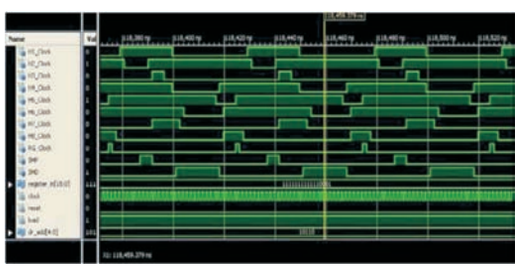


Piezo actuator for auto-focusing



Light weighted PM

Cartosat-3 Structure



Programmable timing generator ASIC- Clocks for TDI CCD

GISAT

GISAT will provide high resolution images on continuous basis from GEO orbit. Payloads will consist of Multi-spectral camera and Hyper spectral cameras. There are number of challenges in terms of spectrometer design, realization and accommodation of all the channels, focal plane test bench development, thermal management etc.

Configurations were finalized. Spectrometer design was optimized with single primary mirror and cut FCO. CE-Modulator integrated test was successfully completed at 200 MBPS. DVM Logic and Control electronics were completed (4 types). HySI VNIR detector mount design was completed. CCSDS Packet generator for HySI-VNIR, MIL-STD-1553 based Payload Controller and cooler drive electronics were completed. Procurement for filters and detectors initiated.

GISAT is configured with phased array antenna as a prime option. Phased Array Antenna is designed as a prime option to cater high performance real time optical payload data to be transmitted to identify set of ground stations in India while the satellite is maneuvering about roll and pitch axis. During this year, alternate antenna options comprising mechanically scanning antenna were realized and tested.

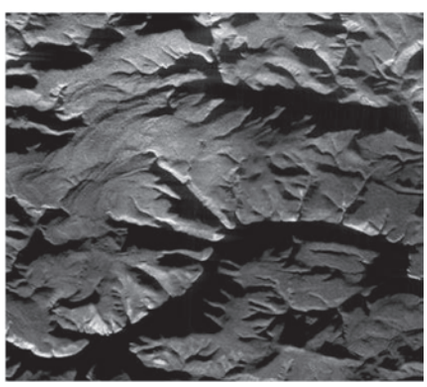
BBM DC-DC Converter for DHE

MIL-STD-1553 Payload Controller

MIL-STD-1553 Payload Controller

RISAT-1

The First HRS imaging in CHRS mode and hybrid polarimetric images of sliding spotlight mode of RISAT was generated. New phase based Doppler centroid estimation methods like Multi-look Cross Correlation (MLCC) and Multi Look Beat Frequency (MLBF) were implemented and integrated with HRS processing software. RISAT-1 Azimuth Antenna Pattern Acquisition using Antenna pattern Measurement System (APMS) and Spectrum Analyzer was carried out. ScanSAR NRTP was installed at NRSC, Shadnagar, Hyderabad. Generic QLP software to process both ScanSAR (RT) and Stripmap mode data using SPECAN algorithm completed. Antenna azimuth pattern evaluation from CAL data completed. Final fully automated NRTP system for processing Stripmap and ScanSAR mode of RISAT-1 data and Software Utilities for HWQLP Maintenance was installed at NRSC, Hyderabad. Integration of HRS Pre-Processor module with the final NRTP software for FRS-1/MRS/CRS installed at NRSC. Antenna correction factors were updated and finalized with effect from September 27, 2013 and verified by measuring Transmitter and Receiver antenna patterns using ground receiver (APMS, Azimuth Pattern Measurement System) and single tone transmission. GUI for the SAR processing software was developed to automate processing for multiple raw-data-sets.



RISAT -1 : NRTP Image over Srisailam, MRS Mode acquired on 11/03/2014

An updated version of RISAT-1 DP Scheduler software was installed at NRSC, Shadnagar with an integrated BDH extraction chain. Software to generate polarimetric parameters from CFRS-1 products was developed and operationalised. A Software to store L-0 RAW data analysis results and database report generation is installed at NRSC. A detailed radiometric analysis over Amazon Rainforest using RISAT-1 Ground Range Products in different beams/incidence angle was carried out.

DMSAR (X-band)

Integrated Test of Operator console, PLC, Receiver, FG, CGDACS, TWTA with Vmetro Recorder were completed. Implementation of NLFM based chirp was generation completed and delivered for integration. X-band system checkout and data analysis completed and Checkout Document generated.

RISAT-1A

Development of End to End NRTP processor for ScanSAR was completed. Mode wise data stripping in NRTP mode from a single dumped (Playback) raw data file was completed. Modified ATS (L & C Band) with RISAT-1 TR Controller for interface, control & serial communication, was tested successfully. Software to process the Level0 calibration data acquired in Antarctica was developed.

RISAT-3 (L-band SAR)

Evaluation of 12-bit ADC 12D1X00 from National Semiconductor on evaluation kit (ADC 12 D1X00-RB) using sine and chirp signals were completed. TRiM testing data analysis was carried out and results were documented. High power testing of L-band SPST switch for integration Block was completed. L band SPDT switch with on chip TTL driver was assembled & tested. Testing of TTD MMIC (from UMS foundry) integrated with LTCC module was completed. TCU hardware & software troubleshooting at Integrated Tile level testing was completed.

Mm-Wave Sounder

Interface testing of PLC, HPDAS and TSU Scan Electronics (TSE) package of Temperture Sounding unit (TSU) was completed. Design, Realization and RF testing of main and sub-reflector & Feed System for 20-30 GHz and 50-60 GHz (DVM) was completed. Design & Analysis of 1.0 m dia. Metallic Reflector (DVM) was completed. Fabrication is Under Progress at VSSC. Mechanical and substrate Compatibility of 91.65 GHz LO chain of HSU was completed.

NI-SAR

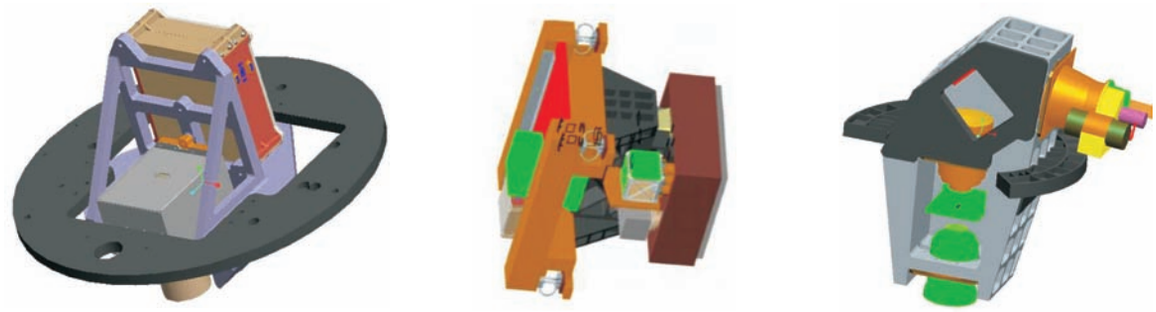
Dual frequency Sweep SAR at L and S-bands is being developed jointly with JPL/NASA where the responsibility of SAC/ISRO is to develop the S-band SAR system.

Design, development and testing of driver stage for 9W output power, medium stage to deliver 25W and Power stage to deliver 45W output power of 40W S Band SSPA was completed. S-Band SAR configuration was finalized. In this year, the RF modeling and analysis of a 12m unfurlable reflector antenna has been carried out. The detail analysis of the optics with unfurlable reflector with the different options of feed array is being carried out. Analysis and characterization of the UFA antenna fed by a Microstrip planar array at L band was carried out.

Airborne Imaging

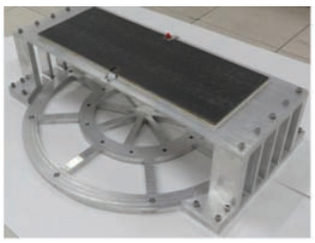
Design & development of mechanical structure & components for A-HySI, A-Nano and A-TMC payloads for nadir & oblique viewing was completed. Configuration design for SWIR airborne instrument which includes design & development of reflection grating mount, structure, lens mount was completed. Design & development of integration components for AHySI & AIMS Payload were completed.

Development of command, control and data acquisition unit for TMC-A incorporating IMU data completed. Carried out installation and testing of HySI-A, TMC-A and Nano-A payloads including IMU in aircraft at Cuttack. All Sensor operations, data recording were successfully carried out in Nadir as well as oblique viewing during the test flights. Carried out and involved in activities related to AHySI, ANano and AIMS-2 flights over Nagpur. Involved in installation and preflight testing of IMU & AIMS-2 in NRSC's aircraft at Hyderabad. Participated in successful flights over Hyderabad & Dibrugarh base from 17th to 23rd Feb, 2014.



Airborne payloads and their mounting structures

Mini-SAR



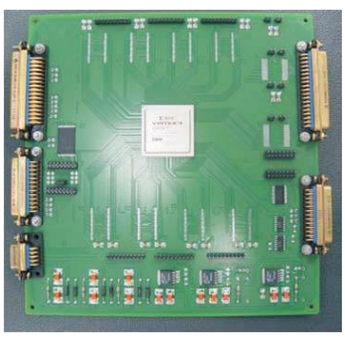
Antenna for MiniSAR at X-band

High Power testing of X band waveguide ferrite switch with 6KW pulse power from TWTA carried out. Testing for DVM EPC for digital subsystems completed. Testing of X-Band branch line coupler for Pulsed Transmitter completed. Testing of DVM EPC for RF subsystems completed.

In this year, design of dual polarized wideband single antenna element with independent polarization control using Electromagnetic Coupling at V pol and Aperture Coupling at H pol has been carried out. Wide bandwidth (~7% at -17 dB RL) has been achieved. Design of 6x16 & 6 x18 dual polarized wideband antenna array at X-Band has been completed.

ADITYA

Aditya-1 will be used to understand physical processes of the sun like heat of the solar corona, solar wind and coronal mass ejections (CMEs). SAC is responsible for design and development of Detection systems. The requirements call for photon level detection, amazingly large dynamic range, low noise, high resolution electronics and advanced signal processing.

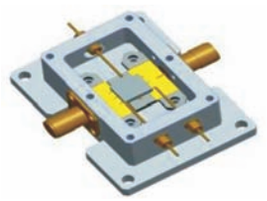


BBM CDPE

Preliminary Design Review of the optical design was completed. List of subsystem packages along with power and mass budget were generated. All camera electronics components were identified. Visible channel BBM photon detection system is under development.

MiniSAR X Band

Development of airborne SAR in X-band is under final stages of testing. Development & Characterization of Elliptical Corrugated Horn Antenna was completed. Various optimal mounting arrangements were worked out of different subsystems on the backside of antenna base plate to minimize size and mass and to bring the entire system within < 5 Kg.



L & S Band Pulsed Transmitter

Testing of S & L band coupler (mirror) with attenuator for ETM was completed. S band phase shifter are assembled and tested.

SCATSAT-1

MATLAB processor for Mode-2 1K FFT option with 32-bit sample precision was developed and actual OceanSAT-II, Scatterometer raw data was processed and results are given to system for analysis. Operational temperature test on DVM EPC for Digital subsystems were completed.

MPI-based program for processing of multiple orbits of Scatterometer data on SIPAHPC system was developed. Designed and developed a graphical interface for the visualization of OAT parameters and onboard calibration data for a selected orbit. FM development is in progress. Design & optimization of 1 m AL reflector

Oceansat-2

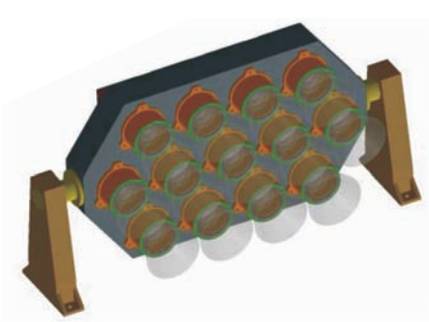
Scatterometer-DP software to handle scan period anomaly was tested and provided at NRSC and EUMETSAT for operationalisation. Multi-threaded software for grid posting and slice compositing of Scatterometer L2A data was developed.

Meghatropiques

A utility was developed to identify payload wise segments in given dumps for raw, Level-0 and Level-1 data and generated consolidated dump wise report. This utility has been provided to operations center at ISSDC. Software for integrating the multiple L1A3 segments (above algorithms) within operational software was developed.

OCM-3

OCM-3 is planned to provide data continuity with enhanced features to the user community on a global scale. OCM-3 which is an improvement over OCM-1/2 will have thirteen spectral bands in the region of 0.407 to 1.020 microns to meet the advanced imaging requirements and application needs. It will have finer spectral bandwidths of 7.520nm for better spectral classification and will provide SNR of 1000 at 360m resolution.



Preliminary mechanical design of OCM-3

System configuration study was carried out. Various options were studied and analyzed in detail. Sub-system options for each configuration were worked out. Single EOM configuration was pursued for further development. Detector development related aspects were discussed with Semi Conductors Laboratory. 3D modeling of different configurations of OCM payload was carried out. Studied compound angle effect in case of two and three heads configurations and computed its effect on total swath of the mission. Preliminary optical design of few bands was completed.

Planetary & Astronomical Missions

CHANDRAYAAN-2

Chandrayaan-2 will cover the moon and supplement/complement Chadrayaan-1 measurements. Terrain Mapping Camera-2 is improved w.r.t. power and weight. Imaging Infra Red Spectrometer is a new camera with spectral range of 0.8-5.0µm will measure absorption by pyroxene, olivine and plagioclase minerals to understand the lunar evolution. Miniature camera is being developed for Rover/Lander monitoring.

Antenna characterization for L-band SAR carried out. The design and development of 40W L-Band SSPA of L-band SAR completed. The configuration for dual frequency common aperture antenna at L/S-band has been finalized and the DVM of the sub-tile of the antenna developed.

TMC - 2 VM

TMC-2 was further miniaturized w.r.t TMC-1 (weight and power reduced to 66%.). PDR of Optics fabrication at LEOS was completed. VM DHA was developed. Miniaturized camera electronics (VM) were qualified. Functional & qualification test of PSE & LCE card of TMC-2 completed. All measurements are satisfactory. Development and testing of Spacecraft Interface Simulator (SIS) and Payload Data Acquisition System (PDAS) with burn-in of TMC-2 was completed. SIS application development and verification of TMC-2 completed. Integrated testing of SIS and PDAS with final application software of TMC-2 completed. Burn-in test of SIS and PDAS completed. Development and testing of second unit of SCCS (SIS-PDAS) and PSI of TMC-2 completed.

IIRS Electronics

Extended Qualification including thermo-vacuum test of RI completed. Acquisition system and acquisition software for camera electronics of IIRS developed. Detailed testing of FECE of IIRS completed. Functional test on BBM Power supply package for CE and cooler electronics of IIRS completed. Vibration & shock test on one qualification model card of Rover Camera was completed. 168 hours burn in and 500 hours of life test of Rover Camera completed and performance are satisfactory.

Testing of L band high Power Amplifier for L-Band Pulsed Transmitter and S band Medium Power Amplifier for S-Band Pulsed Transmitter with TNC connector completed and results are satisfactory. Design of High Power Amplifier MMIC and Medium power amplifier at Ka-band of Altimeter for Lander completed.

Proposal for Hazard Detection and Avoidance sensors (Orbiter High Resolution Camera (OHRC) on Orbiter, On Lander: LTDC, LHDA-Cam, LHDA-FL) were worked out.

Mechanical design, development and realization of breadboard model of X Ray Solar Monitor (XSM) sensor head and Alpha Particle X Ray Spectrometer (APXS) head were completed. Structural analysis (Normal mode and static analysis) of XSM & APXS sensor were completed. Design of different configuration options for the mounting arrangement of Orbiter High Resolution Camera (OHRC) from optical ray diagram was carried out. Design of the overall mechanical configuration of the camera, Lens assembly, Housing, DHA of Lander Position Detection Camera (LPDC) initiated.

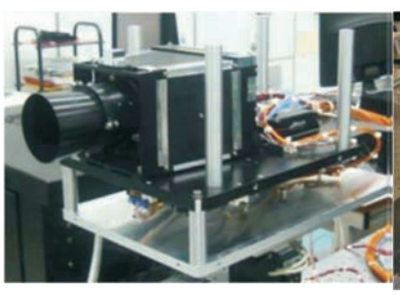
Design, development and characterization has been completed for 1/4th tile SAR antenna, employing new light weight material and processes. The feeding mechanism has been investigated to mitigate the shortfall of gain at L band with mass penalty. Two pairs of Tx and Rx ring loaded horn antenna have been designed and developed for Altimeter payload at Ka band. It meets the stringent mass criterion of 80 grams for all the four horns. QM, FM Antenna development is in progress.

MARS Mission

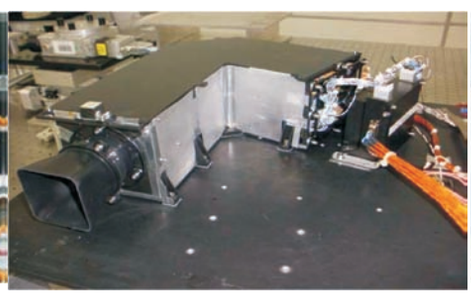
Mars is an object of scientific curiosity as well as specific inquiries due to similarities with Earth in terms of seasonal cycles and thermal environment which is considered to be conducive to the evolution and development of life forms. MOM is the first mission to the MARS. SAC has contributed significantly by developing three of the five instruments/Payloads for Mars Mission Mars Colour Camera (MCC), Thermal Infrared Spectometer (TIS) and Methane Sensor for Mars (MSM). Challenges of identifying scientific objects, developing high reliability instruments for space environment to meet the stringent spacecraft resources allotted while meeting performances and delivery of instruments with-in a period of one and half years was met.

A High Gain Antenna is required on-board the Mars Orbiter spacecraft for TTC and data transmission function at S-band during various phases including Mars orbit. An offset parabolic reflector antenna is proposed to achieve the required gain of better than 30dBi for satisfactory link establishment. The antenna mould was developed. The antenna systems were fully characterized in SAC CATF. The feed chain consists of an octagonal horn as primary radiator and a septum polarizer for achieving dual circular polarization. A light weight and compact feed chain is designed and realized.

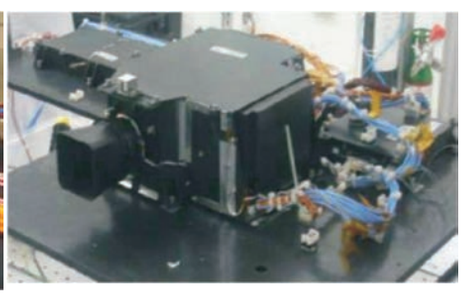
All three payloads were switched ON and Telemetry and housekeeping parameters were verified. Dark-space view data is acquired for all three payloads and performance was verified. Performance is found matching with Lab data. Post Launch exercise of Mars Orbiter Mission (MOM) in Bangalore with data analysis exercise was carried. Software Set-up was established at ISSDC for Quick Evaluation MOM In-orbit data. In-orbit data analysis for all the three payloads and comparison of On-board performance with that ground data set carried out. Development of MCC, TIS and MSM FM spare model Camera electronics completed and kept in bonded store. All three payloads (MCC, MSM & TIS) are operated during cruise phase and dark performance evaluated.



MCC

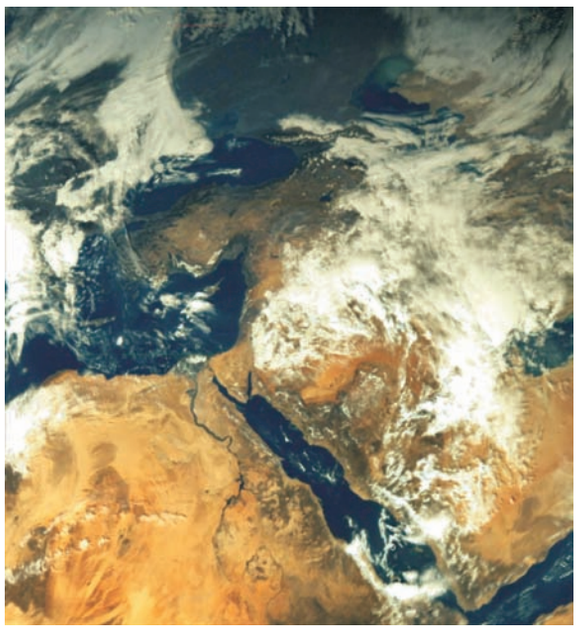


TIS

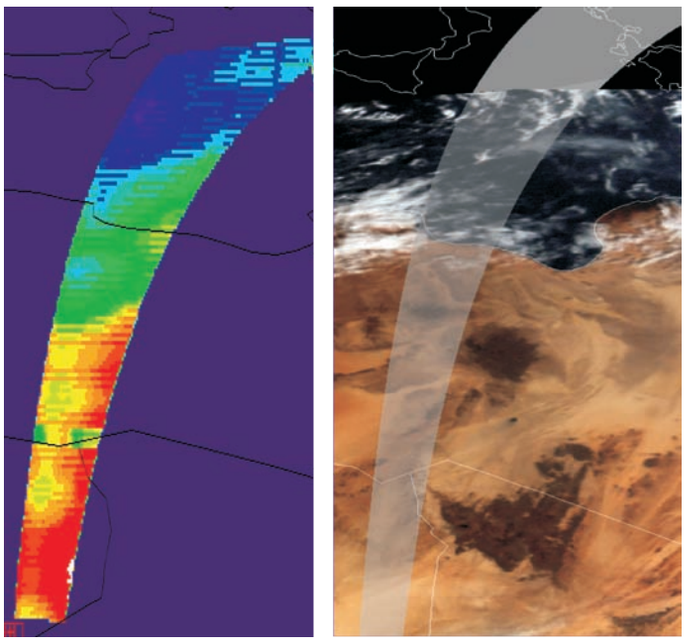


MSM

MOM Imaging Sessions		
Session No.	**Date & time**	**Imaging mode**
1	19th Nov 08:20 UT	Earth Imaging
2	19th Nov 11:20 UT	Earth Imaging
3	23rd Nov 08:00 UT	Earth Imaging
4	06th Feb 17:21 UT	Deep Sky
5	13th Mar 16:21 UT	Deep Sky



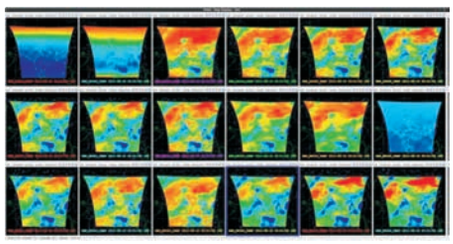
MCC data acquired on 19-11-2013 11:30 UT over Arabian Region



TIS Data Acquired over Sahara Desert on 23 Nov. 2013 at an Altitude of 21461 km, Nominal Res: 14 k. Brightness Temperature derived by payload & science team

Remote Sensing Data Products Applications

INSAT-3D



INSAT-3D was launched on July 26, 2013. It carries 6 channel multi-spectral Imager, 19 channel Sounder, Data Relay Transponder (DRT), Search and Rescue Transponder (SRT) and MET transmitters.

INSAT 3D image data for Imager and Sounder was provided to Data Processing team through Data Reception System for IMDPS. Input for Configuration handbook and Flight Control Procedure prepared and submitted to the Project. In-orbit tests were completed and results are satisfactory. Analysis of Sounder and Imager data carried with IMDPS team. DR Software system re-created and installed through NKN link & established Data Reception System at IMD, New Delhi for receiving data from both Imager and Sounder payloads. IOT phase-II with Antenna Pattern Measurement was carried out. Payload performance is normal. IMDPS Data Reception Software for Imager augmented to transfer AOCS data to DP during Scan-Off period, with dual port RT data write, and seamless file generation. Sounder Redundant DR chain was operationalized at BES, BOPAL. Software for in-orbit TM Data Analysis of Sounder was also developed. Operation directives for different operations of the SOUNDER payload were generated.

INSAT DP (IMDPS) & Special Products Software

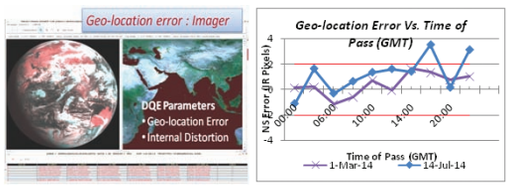
INSAT-3D Data Products generation software was installed at IMD, New Delhi to generate simulated products of Imager and Sounder operationally. Integrated Calibration for Imager and sounder to Radiometric Correction process and testing was carried out. Design and development of automatic registration of INSAT-3D imager data completed.

Development of proto-type Database Retrieval software for L-0 DQE for Kalpana-1 was completed. First day INSAT-3D Imager data acquired on August 7, 2013 and 19-channel Sounder data acquired on August 8, 2013 was processed successfully. Online Data transfer of INSAT-3D from DR to DP was operationalized. INSAT-3D Meteorological Data Processing System (IMDPS) was dedicated to Nation at National Satellite Meteorological Center (NCMC) , IMD, New Delhi by Dr. S. Jaipal Reddy, Honorable Minister of Science & Technology, and Earth Sciences On January 15, 2014.

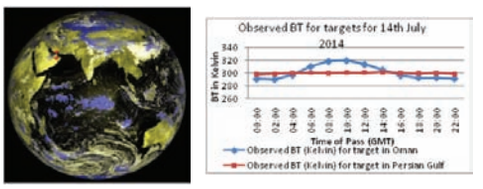
All systems demonstrated during dedication ceremony, in presence of Minister ST & ES. Module to send automated mail notification for INSAT-3D (imager) earth disc shift was designed, implemented and operationalised at BES.

INSAT 3D DQE

Data Quality Evaluation System for INSAT-3D is operationalized at MOSDAC, Bopal. Raw data of all acquisitions is processed automatically for generation of payload health statistics. Six-hourly data is analyzed to provide regular feedback on geometric accuracy of Imager and Sounder products. Report circulation mechanism by automatic-email is established.



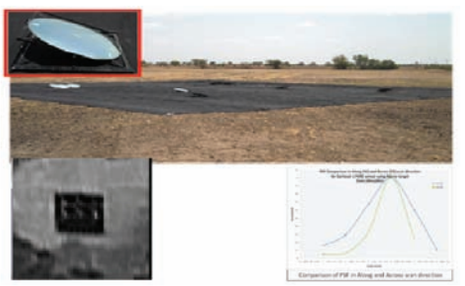
L-1 GDQE: Diurnal Variation & Pre-Post Yaw Flip Comparison of Geo-location Error


Observed BT for targets for 14th July 2014
BT in Kelvin
Time of Pass (GMT)
Observed BT (Kelvin) for target in Oman
Observed BT (Kelvin) for target in Persian Gulf

L-1 RDQE:Variation of Radiometry (BT & SNR) for Desert & Sea Targets (TIR-1, Imager)

CAL/VAL

The performance of OCM-2 over four-year period (2010-14) using Moon as calibration source was presented at various forums and feedback on the same given to Oceansat-2 mission. Intra-mission inter-sensor calibration between RS2-AWF and RS2-L3 was carried out and the feedback on the coefficients given to concerned team. Validations of the above coefficients are carried out on 4 data sets of RS-2 L3/AW.



PSF of Cartosat-1 sensor using Convex Mirror point targets

Mirror target deployment for simultaneous spatial characterization of Cartosat-1 Fore and Aft sensor at Rojasar site was carried out. Analysis for Mirror-based PSF estimation experiment data completed including documentation (Refer Figure-3). TDP on Development of Operational procedure for vicarious calibration of Optical Sensor was successfully completed. Comparative results between band integrated ground measured radiance and sensor measured radiance for all datasets over two sites were generated. Moon calibration plan for radiometric calibration of sensors is being worked out for RESOURCESAT-2A. Initiated establishment of calibration related facility for forthcoming Cartosat-2C mission.

IMGEOS DP

Maintenance of DPGS software for Resourcesat and Cartosat series was performed, which included addition of new features and fixing of bugs discovered in the software. The DPGS s/w for Cartosat was augmented to handle (i) full scene ortho-rectified data products for Cartosat-1 and Cartosat-2 using CartoDEM/ASTER DEM, (ii) HDF product, (iii) Utility for improving data products accuracy. An inter-centre Configuration management review board (CMRB) has been formulated which gives guidelines to submit software patches and to perform change and bug/issue management. SAC DP team is fully complying CMRB guidelines and procedures for s/w updates.

IMGEOS DQE

Integration of RISAT-1, RESOURCESAT-1 and RESOURCESAT -2 DQE software systems in IMGEOS environment completed. Project level test and evaluation was also completed successfully. Established DQE interface with unified reference database (URDB) in IMGEOS environment. Operationalization of

Auto-GDQE software for geometric evaluation of IRS data products in IMGEOS environment is initiated. Integration of CARTOSAT-1 and CARTOSAT-2 DQE software in IMGEOS environment is in progress. CMRB procedure established for IMGEOS DQE.

Reference Image Generation

RESOURCESAT-2 L4FMX Reference image generation and qualification using AUTOGDQE procedure was completed. These images cover Indian landmass. The images are ported to NRSC, populated in URDB and being used operationally in ground segment processing chain. AWiFS global reference images generation was initiated. Test products were generated and qualified.

RISAT-1 DP

An updated version of RISAT-1 DP Scheduler software was installed at NRSC, Shadnagar with an integrated BDH extraction chain. Software to generate polarimetric parameters from CFRS-1 products was developed and operationalised. A Software to store L-0 RAW data analysis results and database report generation is installed at NRSC. A detailed radiometric analysis over Amazon Rainforest using RISAT-1 Ground Range Products in different beams/incidence angle was carried out.

RISAT-1 DQE

Augmented point target analysis software for RISAT-1 using advanced approach. Feedback provided on RISAT-1 Raw data quality by analyzing around 300 raw data products of FRS-1. Inputs given for RISAT-1 SAR calibration by corner reflector based point target analysis.

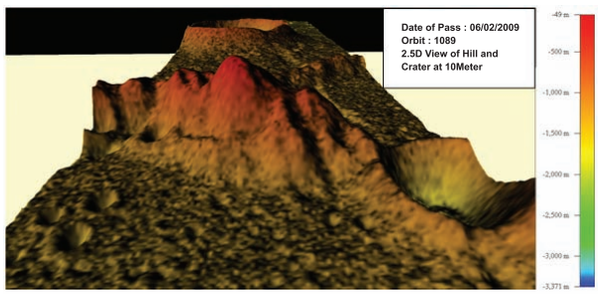
Oceansat-2 Scatterometer DP

SCAT-DP software to handle scan period anomaly was tested and provided at NRSC and EUMETSAT for operationalisation. Multi-threaded software for grid posting and slice compositing of Scatterometer L2A data was developed.

MARS DP S/W

Integrated Test and Evaluation of MOM Data Processing pipeline was completed at ISSDC, Bangalore. Aero-tagging module for MOM implementation was completed. The implementation is tested using sample ephemeris information supplied by mission team. Camera Model implementation for MCC was completed. First day products were generated successfully and payload performance was evaluated. Mars-1 Data Processing (DP) Chain inside the DP Scheduler and PDS data archive pipeline was modified as per the Cruise Enroute to Mars (CEM) mission phase requirement and was deployed at ISSDC and assessment of the payload performance with respect to two imaging sessions was carried out during Earth bound phase.

Chandrayaan-1

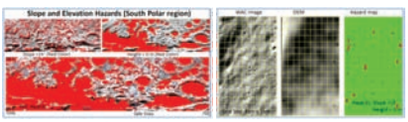


Long Term Archive (LTA) for five instruments of Chandrayaan-1 viz., TMC, HySI, SARA, M3 and MiniSAR were released on April 19 along with Lunar DEM, generated from possible passes of TMC stereo data and samples of Lunar Atlas. As part of higher level

product generation at SAC Payload Operations Center (POC), DEM and Ortho image generation towards the Lunar atlas preparation is one of the major activity carried-out. Currently completed generation of irregular DEM for 818 orbits, generation of regular grid DEM at 10 meter postings for 340 orbits and detailed qualification of DEM and Ortho image is being carried-out.

Chandrayaan-2

Preliminary design and development of algorithms and data processing requirements for detecting potential hazard during Lander descent and optical image processing based input support for navigational instruments (control system) have been completed under Hazard Detection and Avoidance (HDA) for soft landing.



Landing Site Characterisation

Landing Site Identification for Chandrayaan-2 Lander: Landing sites identification is one of the major challenges in Chandrayaan-2 mission; they are normally selected on the basis of Technical and Scientific criteria. The technical criteria include safe landing (Hazard free area) and local mobility (Global and Local Slope) and Operational constraints (Earth visibility and Sun illumination, temperature and accuracies of the landing instruments). The scientific criteria include the surface composition, local geology and environments. A detailed terrain characterisation based on Elevation, Slope, Aspect Error ellipse and global illumination has been completed for north and south polar area of moon and identified a total of 64 landing sites which was further analysed by the mission for illumination due to local slopes and 04 sites were finally selected.

DEM Generation and Path Planning for Rover Navigation:

Established Close range Image acquisition and processing facility at SAC Bopal campus for simulating NAVCAM stereo images for DEM generation and path planning for rover navigation. The stereo camera for this activity was provided by LEOS.

Astrosat DP

The initial versions of Level-2 Pipelines for all payloads (LAXPC, SXT, CZTI, UVIT) have been developed during 2013-14. One version of Level-2 software is delivered to the Principal Investigators for SXT, LAXPC and CZTI. UVIT initial version will be shared with PI during this year. Feedback and modifications suggested by PI have been incorporated in the s/w. Quick Look Display package for all four instruments is already developed and ported & tested at ISSDC. Data archival, Browse and Dissemination s/w is being developed and initial version will be delivered to ISSDC.

Meghatropiques data processing and DQE

Developed a utility to identify payload wise segments in given dumps for raw, Level-0 and Level-1 data and generate consolidated dump wise report. This utility has been provided to operations center at ISSDC. Developed software for integrating the multiple L1A3 segments within operational software. Operationalization of SAPHIR/SCARAB L-0 and L1 DQE software and development of a web based tool for MeghaTropiques report visualization is completed.

Cartosat-2C DP and DQE

Cartosat-2C is the next mission in the Cartosat-2 series and it contains multispectral and panchromatic sensors with TDI arrays which will result in higher signal-to-noise ratio for images. In the last one year, Ground Segment PDR along with a number of ground segment meetings was completed. Many issues were discussed and resolved for proceeding towards the detailed design. Interfaces with other centers have been worked out and were deliberated during the PDR. Preliminary software design is completed. Simulation studies have been carried out which includes PAN, MX and EVM cameras. TDI Image simulations with various factors affecting image quality were done. Valuable feedback has been given to project based on which some important decisions have been made. TDI Multispectral and EVM cameras (EVM-1 and EVM-2) simulated images have also been generated. TDI imaging algorithm is part of the multispectral image simulations. Work towards detailed design is in progress.

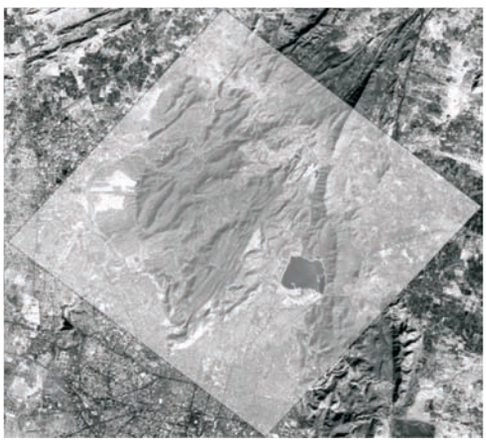
DQE parameters for monitoring geometric and radiometric quality are identified. Moon calibration plan for sensor calibration is prepared. Point Spread estimation using Stellar images and Mirror targets is proposed.

CartoDEM/GlobalDEM

CARTODEM software system was updated with modules for handling some reported anomalies, interactive module which support GCP collection from public domain. Project for generation of Global DEM from available CARTOSAT-1 stereo data sets was approved by EOA-MC.

1) Computer infrastructure realization is in progress.
2) Proto type software development competed. First version of DEM generated for 26 segments (paths) data sets over South American continent.

New modules developed for (a) generation of reports at various stages for quality evaluation and analysis of resultant DEM & Orthoimages, (b) visualization and analysis of resultant DEM & Orthoimages



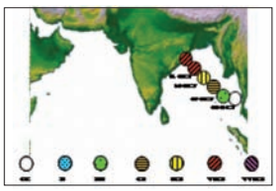
Cartosat - 2 Orthoimage Overlaid Onto CartoDEM Tiles

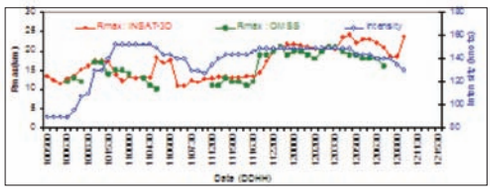
FASAL Soft Project (software design, implementation & operationalization)

Integration of RISAT-1 DATA analysis in the FASALSoft Software was completed and deployed the Software at M-NCFC. Regex (Regular Expression) enabled Rule Based Classifier Module was delivered to M-NCFC. Mosacing and Registration processes of RISAT-1 MRS images was deployed at M-NCFC for Kharif Rice forecasting.

Earth Observations Applications

INSAT - 3D Data Utilisation





model based prediction of cyclone (left) and Rmax using INSAT-3D (right)

Retrieval algorithms for INSAT-3D were made operational in IMDPS system at SAC and IMD. After Initial fine-tuning and validation the IMDPS system was dedicated to nation on 15 Jan 2014 (IMD's foundation day) by Hon Minister (Science & Technology and MoES) Dr S. Jaipal Reddy. INSAT-3D L1B radiance were evaluated and corrected using established GSICS (Global Space-based Inter-satellite Calibration System) procedure. A procedure has been setup to provide regular GSICS correction coefficients on a day-to-day basis to generate GSICS compatible Imager and Sounder radiances. Extensive validation carried out for various parameters shows that the accuracy of INSAT-3D products is within reasonable limits, with scope for further improvement. Rainfall estimation from H-E method was made operational at MOSDAC portal.

SARAL Science and Applications

Near real time analysis of Sea level and wave height from AltiKa and Jason-2 data for cyclone Phailin has been carried out. SARAL Science GDR, data made available through MOSDAC to all the national users. AltiKa sea level data has been able to add 10-15% improvements in data assimilation in ocean models providing useful information near the coast. Improved accuracy of seasonal river level variations in Brahmputra river for the estimation of flood and water discharge. A presentation on overall progress on SARAL Science Applications from ISRO was made in First SARAL-AltiKa (OGDR, IGDR) data Verification Phase Workshop at Toulouse-France organized by CNES. SARAL International Science and Applications Meeting was organized in which several International and national participants made presentations on the progress of the work. To derive accurate sea surface height near Gujarat coast, various retrackers have been tested on SARAL/AltiKa 40-Hz waveform.

Meteorology & Oceanography Programme

Procedure for assimilation of INSAT-3D radiances was implemented in IMD's operational system. INSAT-3D radiances and AMVs are now routinely being assimilated into the NWP model from IMD and NCMRWF. Initial assimilation results from NCMRWF shows that AMV has positive impact on rainfall forecast. AMVs are now transmitted on GTS and assimilated in global models on operational basis. A statistical model was developed to predict potential locations for severe precipitation events using half hourly INSAT-3D observations over Uttarakhand that has high positive (66%) and low false detection rates (17%) with a location accuracy of 30 km. The forecast experiment for cloud burst in June 2013 was carried out successfully with a lead time of 4 hours. These forecasts are disseminated through MOSDAC. Real time predictions of the cyclones were generated and the warnings were disseminated through the SCORPIO/MOSDAC. HWRF model was customized for the north Indian Ocean and used for real-time prediction of cyclone intensity and rainfall.

Forecast experiments were conducted using the Community Atmosphere Model (CAM) during 2014 to forecast the Indian summer monsoon (ISM) rainfall. A trend analysis of the rainfall from historical data was studied and it was found that the number of rainy days is decreasing and extreme rainfall events are increasing.

Data-assimilative circulation model have been implemented at MOSDAC with assimilation of SARAL/AltiKa data. Storm surge predictions were made for all the cyclones, including Phailin, during the and results have been provided through MOSDAC. Simulations from coupled ocean-ice model have been evaluated using satellite derived ice parameters for the period 1980-2010. Satellite and model derived temperature and sea level have also been analysed in the equatorial Pacific and El Nino Outlook has been prepared. Satellite and model based information on oceanic features and atmospheric conditions are being provided to ship cruises in the Bay of Bengal for fine scale process studies.

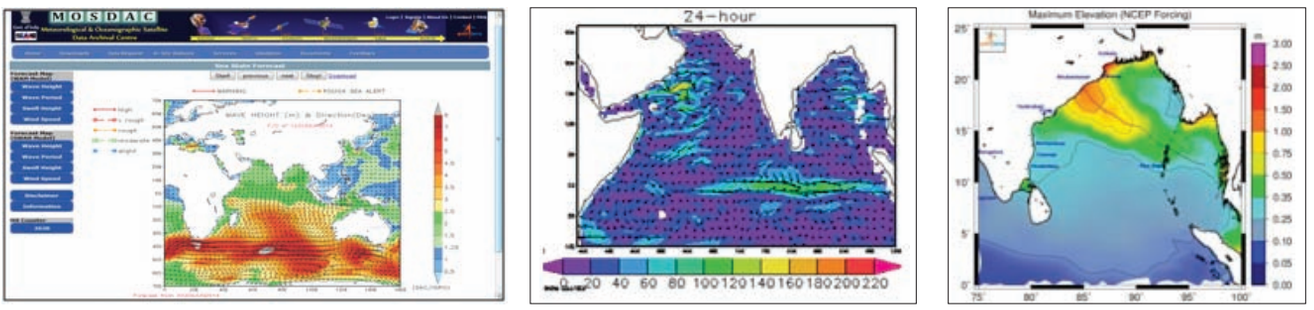
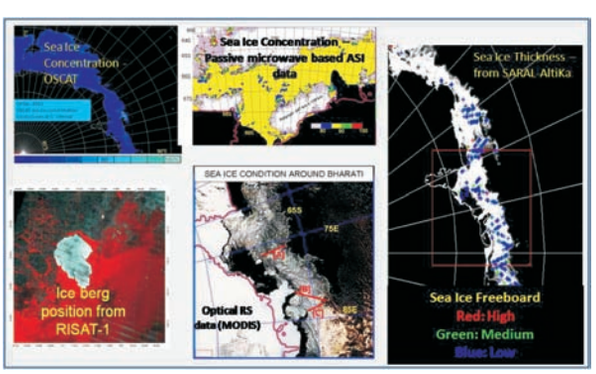
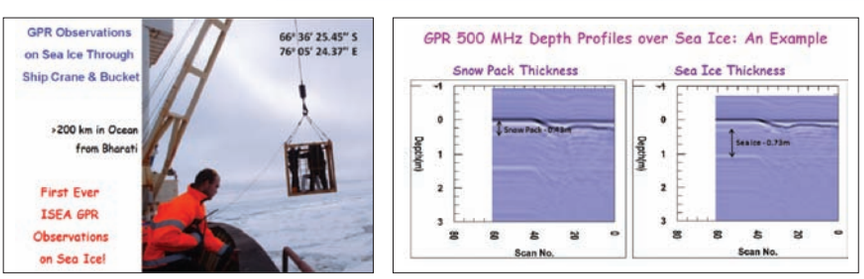


***Figure:** Snapshots of typical samples of forecasts available operationally a) Wave forecast available at MOSDAC portal, Indian Navy and during Indian Ocean Ship Cruise for Monsoon Mission b) Total Current available at Indian Navy and for Monsoon Mission Ship Cruise c) Storm surge forecast available during Cyclones over Indian waters.*

Near real time sea ice advisory have been provided to NCAOR using multi-sensor remote sensing data for Antarctic expedition and it was found critical by voyage leader to cross the sea ice regions around Bharati and Maitri. Two scientists have participated in the 33rd Indian Scientific Expedition to Antarctica and collected various important data using SAC developed Ground Penetration Radar (GPR) and other instruments. Ice thickness profiles were collected using GPR, developed by SAC over (i) ice sheet sites around Maitri; and (ii) sea ice sites around India Bay. For the validation of GPR derived ice thickness estimates, physically measured snow pack and ice depth measurements were also collected over frozen parts of Priyadarshini Lake (Maitri). A study carried out to investigate the association of ice-shelf advancement with surface melting indicated by scatterometer derived Melting Index (MI).


Sea Ice Concentration - OSCAT
Sea Ice Concentration – Passive microwave based ASI data
Sea Ice Thickness – from SARAL-AltiKa
SEA ICE CONDITION AROUND BHARATI
Ice berg position from RISAT-1
Optical RS data (MODIS)
Sea Ice Freeboard
Red: High
Green: Medium


GPR Observations on Sea Ice Through Ship Crane & Bucket
66° 36' 25.45" S
76° 05' 24.37" E
>200 km in Ocean from Bharati
First Ever ISEA GPR Observations on Sea Ice!
GPR 500 MHz Depth Profiles over Sea Ice: An Example
Snow Pack Thickness
Sea Ice Thickness
Depth(m)
Scan No.

The Critical inputs provided during the Antarctic expedition to NCOAR b) Scientific observations carried out during the 33rd Antarctic expedition.

RISAT-1 Utilisation Programme

A Workshop-cum-Final Review Meeting of RISAT-UP was organized on March 25-26, 2014 at Space Applications Centre, ISRO, Ahmedabad. Successful completion of Projects on various identified themes

along with and from various ISRO Centres, Academic Institutes and other Central/State Departments, and release of TARANG s/w for processing RISAT-1 SLC data and identification of future research elements are the major highlights. (ii) RISAT-1 MRS data has been analyzed to delineate glacial zones of Gangotri and Mana glaciers of central Himalaya for the period of July, 2012-September, 2013. Temporal variation of snowline of Gangotri glacier has been observed from optical data for more than 30 years, (iii) Penetration capability of RISAT SAR data could be demonstrated by detecting snow covered moraine dammed glacial lakes in parts of Himalayan region using multidate MRS RISAT SAR and AWiFS data of winter season.

Programme on Climate change Research In Terrestrial environment (PRACRITI)

Regional SST based coral bleaching thresholds for Lakshadweep, Andaman and Nicobar have been generated following NASA NOAA's CRW_MMM Climatology Model. In situ experiments have been carried out for understanding water column contribution for reef substrate signatures; In situ hyperspectral data have been analysed; Kd coefficients have been computed from the in situ data.

Total 190 river basins have been delineated over India for the analysis of water balance. ISRO satellite based data products has been compiled for whole India and hydrological site specific datasets has been shared to collaborating institutions for model development and testing. Bias corrected climate change scenarios has been prepared to study the impact of climate change.

Standardization of method for GPP estimation: Maximum light use efficiency, minimum, maximum and optimum temperatures for photosynthesis computed from the in-situ measurements for major mangrove species. Method standardized using in-situ measurements and archived winter season data over Lothian Island, Sundarbans.

SNOW AND GLACIER STUDIES-Phase II

Basin wise snow cover monitoring at 5 and 10 day interval for time frame 2008-13 using AWiFS data for Indian Himalayan region (2673 snow cover products/year for 35 sub-basins & 7 Atlases/Year is being carried out. 16 Snow Cover Atlases are prepared (2 for 2012-13, 7 for 2011-12, 2 for 2009-10 & 5 for 2008-09). Dissemination through NRDB has been initiated.
Around 2018 glaciers for time frame 2000-2010 have been monitored using multidate satellite data and the analysis show that 87 % of the glaciers are showing no change, 12 % are retreating and 1 % glaciers have advanced during the period 2000-2010.

Estimated Glacier mass balance for ~ 800 glaciers for year 2010 and 2011. Positive mass balance is indicated for ~ 81 % of glaciers of 10 sub-basins for the year 2010 and 2011 based on monitoring of snow line at the end of ablation season and Accumulation Area Ratio approach.

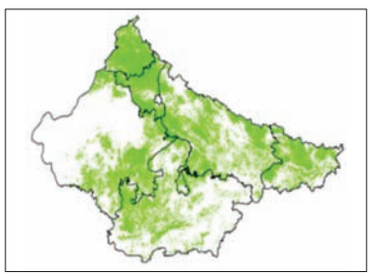
Nine expeditions were organised during August-October, 2013 viz., glaciated region of J&K, Himachal and Sikkim; Bathal, Chhota Shigri, Kolhai, Machoi, Rulung, Yume Samdong, Changme Khangku, Hoksar and Thajwas glaciers. Activities carried out during glacier expeditions include glacial snout validation using GPS/DGPS, in-situ measurements of spectral properties of snow and glaciers using spectro-radiometers, glacial features identification, glacier thickness estimation using GPR, surface roughness measurements using profilometers, black carbon measurements using athelometer, collection of other data such as temperature, humidity, wind, establishment of AWS and glacial lab near Chota Shigri glacier.

MRSA GPR testing at Bathal Glacier, H.P.
Lab inside view
Glacier Science Laboratory, Chhota Dara
GPR at Machoi Glacier, Drass
AWS (Chotasigri , HP)
Aethelometer at Machoi Glacier, Drass

Nine expeditions were organised during August-October, 2013 viz., glaciated region of J&K, Himachal and Sikkim; Bathal, Chhota Shigri, Kolhai, Machoi, Rulung, Yume Samdong, Changme Khangku, Hoksar and Thajwas glaciers

FASAL R&D

Sugarcane in Uttar Pradesh



Rabi Crop

Early assessment of sugarcane was made in July and final estimate in November for major states. During the current year F1 estimate of sugarcane was carried out at MNCFC as part of operationalisation and SAC was involved in giving training, ground truth and digital analysis. Rice crop- RISAT based yield models was given to MNCFC for operational forecast F3 for rice growing states. The spectral yield models for six major wheat growing states (Punjab, Haryana, Rajasthan, MP, UP and Bihar were developed using various remote sensing and other inputs and given to MNCFC for operational forecast F3. Cotton acreage and production estimation using RS-2 AWiFS data for AP, Gujarat, Maharashtra, MP, Punjab, Haryana and Karnataka states. Early assessment of cotton crop using multidate RISAT MRS data for the states of Punjab, Haryana, Gujarat, Maharashtra and Karnataka states were made. Rabi Sorghum acreage estimation using RS-2 AWiFS data for 2013-14 for Maharashtra and Karnataka states. The techniques development for crop discrimination and area estimation of finger millet, sorghum, maize, groundnut and pearl millet was attempted using multidate MRS and one Radarsat-2 polarimetric data over selected study sites.

A remote sensing assessment of Bringing Green Revolution in Eastern India (BGREI) programme was carried out in the state of Odisha state using RISAT data in 2013-14 for the kharif paddy. Rabi Pulses Intensification under National Food Security Mission was carried out for parts of Madhya Pradesh, Uttar Pradesh and Karnataka using AWiFS data. The development of methodology for wheat rust disease detection based on controlling meteorological factors and remote sensing inputs was carried out. Temporal rabi progress area from Indian geostationary satellite INSAT 3A CCD was operationalised at

MNCFC. The periodic soil moisture assessment and crop suitability assessment were generated at fortnightly intervals as maps to DoA. Prototype Web-GIS based tool for temporal assessment of crop / vegetation condition using remote sensing and weather was developed.

New Project Coordinated programme on Horticulture Assessment and Management using geoinfromatics (CHAMAN) was initiated by DAC, MoA. SAC played crucial role in development of this project and has responsibility of developing RS techniques for the project.

Agro ecosystem studies

In the energy and mass exchange in the vegetative systems project Validation of evapo-transpiration (ET) estimates from single-source energy balance and INSAT data was carried out using AMS-based point measurements over limited sites. Validation of INSAT- based Gross Primary Productivity (GPP) for C3 crop (e.g. wheat and kharif rice) by comparison with MODIS GPP. Spatial disaggregation of evaporative fraction from coarser to finer resolution was carried out using inverse right-angle method and validated with AMS data. The photosynthetic rates and light use efficiency in some arid C3 crops and grasses in vegetative and reproductive stages were studied.

In the farming systems project delineation of major farming systems at district level completed for five states. All India district level crop residue database has been created in GIS along with the derived secondary information such as nutrient content (NPK), carbon content and energy equivalent of the crop residue.

Assessment of foreign crops using AWiFS and RISAT data was carried out in selected sites of South fork watershed, Iowa state, USA, Canada, Pakisthan and classification was carried out. The RISAT data over Indonesia, Thailand and Vietnam (South and North) were acquired from October 2013 to March 2014 and decision rule based classification of rice areas was carried.

DESERTIFICATION STATUS MAPPING OF INDIA- 2nd CYCLE

Desertification Status Mapping on 0.5 M scale using AWiFS data of 2012-13 time frame is completed for 11 States. Changes with respect to earlier mapping using AWiFS data of 2003-04 time frame are brought out. Desertification Status Mapping at 1:500,000 scale using AWiFS data was completed for 17 states (Maharashtra, Odisha, West Bengal, Assam, Meghalaya, Himachal Pradesh, Uttaranchal, Punjab, J&K, Karnataka, Andhra Pradesh, Haryana, Tamil Nadu, Madhya Pradesh, Chhatisgarh, Rajasthan and Sikkim).

DISASTER MANAGEMENT SUPPORT PROGRAM

Dual frequency GPS data of IGS Station MIZU near Tohoku in Japan (four years duration) was analysed to derive Total Electron Content (TEC) and understand the ionospheric perturbations related to 9.0 M earthquake of 2011. Analysis of TEC data related to M7.9 Kachchh earthquake in conjunction with geomagnetic indices was carried out. Analysis of TEC data for four earthquake which occurred in Japan between 2005-11 time frame along with geomagnetic indices (Kp, Ap and DST) using four hour average method was completed.

PLANETARY SCIENCES

MARS

Analysis of Mars Orbiter Mission (MOM) imaging payloads: Analysis of Mars Orbiter Mission (MOM) imaging payloads has been carried out during Earth-bound phases on 23rd November 2013. Mars Color Camera (MCC) data acquired over Sahara desert was analyzed qualitatively as well as quantitatively. Comparisons with contemporary satellites were made and appeared promising. Also, observations/experiments were carried out by the Thermal Infrared Imaging Spectrometer (TIS) on the scene acquired over the Saharan desert. The TIS data analysis of this representative scene showed variability in the TIS observed radiance between ~0.5 to 11 Wm-2sr-1μm-1 and the performance of the TIS instrument was found in good agreement with laboratory measurements.

Study of Mars and Martian analogues: Aqueous minerals, such as, hydrous sulfates (gypsum and jarosite), phyllosilicates (montmorillonite, illite, chlorite and vermiculite) have been detected using MRO CRISM Hyperspectral data in parts of Noctis Labyrinthus near Tharsis Mons area. Geomorphological features such as impact craters, lava channels, interior layer deposits and sand dunes have been detected by MRO-HiRISE in the area of Capri Chasma of Valles Marineris. Mafic silicates and aqueous minerals on Capri Chasma region of Mars have been investigated by Odyssey-THEMIS data sets with the help of emissivity and temperature images. Spectral signatures of major Martian minerals have been investigated in the thermal range (7 μm to 15 μm) at MOM-TIS resolution. Red bole beds rich in phyllosilicates minerals have been found at a probable Martian analogue site near Aurangabad region of Maharashtra. A closure report and a spectral catalogue of Martian analogue minerals have been prepared under the TDP R&D Programme of DOS-ISRO on “Spectroscopic, petrographic and geochemical analysis of Martian analogues in India”. Jarosite, a key Martian mineral having astrobiological significance, has been reported for the first time from laterite profile developed over the Deccan Volcanic Province of Kachchh at Matanumadh, Gujarat. Also, an Al-rich phyllosilicate over Fe-Mg-smectite stratigraphy has been identified within the laterite-saprolite horizon at Matanumadh similar to those reported from the Mawrth Vallis and the Meridiani Planum regions on Mars.

MOON

Chandrayaan-1 hyperspectral data have been analyzed over Sinus Iridum region on the near side of the Moon where orthopyroxene-olivine-spinel (OOS) suite of rocks have been detected along the inner ring of this moderately large impact basin. More interestingly, this study could also detect the presence of magmatic water in association with the olivine of possible mantle origin. Also, several new locations of Fe-Mg-spinel bearing lithologies have been identified from various parts of the Moon, namely, Sinus Iridum, crater Letronne, Montes Teneriffe, Mons Pico, Bucher, Craters Olbers A, Gassendi A and crater Moretus in the South Pole Aitken basin. Chandrayaan-1 Lunar Science Atlas has been published. Also, a detailed geological evolutionary model for Compton-Belkovich Volcanic Complex (CBVC) has been put forward, where highest concentration of magmatic water of ~0.55 weight percent has been recorded in association with silicic magmatism based on remote spectral measurements from Chandrayaan-1 mission. Magmatic water of endogenic nature is also detected from two spatially separated silicic volcanic domes from the near side of the Moon at Gruithuisen Domes and Hansteen Alpha. A new litho unit has been detected for the first time using Chandrayaan-1 Moon Mineralogy Mapper data that comprises of olivine-chromite co-existing phases in a troctolite exposed along the inner terraced walls of crater Aristoteles. Crater Aristoteles show diverse litho units, such as, troctolites and gabbros along the crater rims and terraced crater walls and norites in the central peaks. A catalogue of lunar domes has also been prepared. The gravity field is a fundamental physical quantity for the study of the internal structure

and the evolution of planetary bodies. The gravitational field of the Moon has been determined by analyses of radio tracking data of orbiting spacecraft, which include data from the Lunar Orbiter, Apollo, Clementine, and Lunar Prospector missions. Analysis of high resolution gravity, topography data sets along with refined crustal thickness will provide insight into nature of isostasy and difference in evolution of basins on near and farside. Gravity Recovery and Interior Laboratory (GRAIL), a twin satellite mission based on GRACE concept, was launched in September, 2012 to study the interior of moon. In our study Freeair gravity anomaly map of moon to the degree 420 using gravity model GL-420A from GRAIL mission. This gravity model having the spatial resolution of 25 km. Bouguer gravity anomaly map of the Moon is also prepared using the same gravity model assuming the crustal density of 2560 kg/m3 and lunar topography generated from Lunar Orbiter Laser Altimeter (LOLA) data set. Estimation of crustal thickness using recent gravity model of GRAIL mission and topography (LOLA) data sets are in progress.

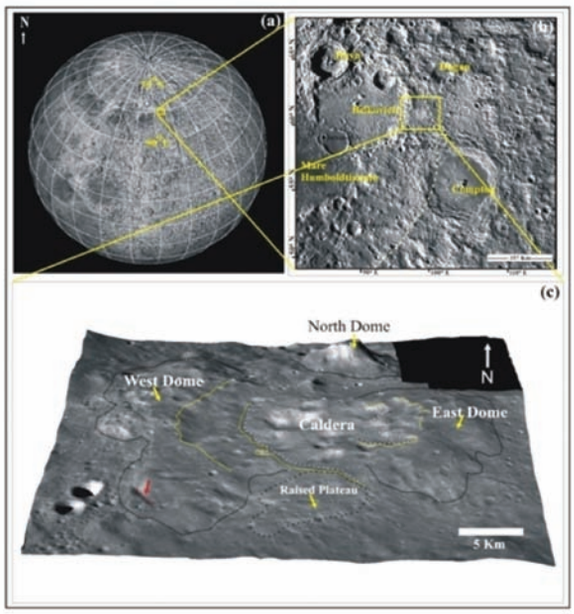


Figure: *Location of Compton-Belkovich Volcanic Complex on the Moon (a) and (b) and; (c) 3D surface view of the area at full resolution derived from NAC image of the area draped over the LOLA DEM with a vertical exaggeration of six, showing the three prominent domes, along with the central caldera roughly marked by its topographic (yellow) and structural (white) boundaries and slightly elevated plateau is the south. The red arrow marks a linear vent feature over the dome.*

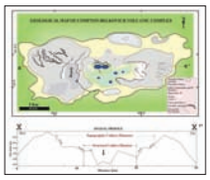


Figure: *Geological map of CBVC prepared from contour generated from LOLA DEM of the area showing its various volcanic features and profile generated along XX' showing the topographic variation along the West and East domes and the central caldera.*

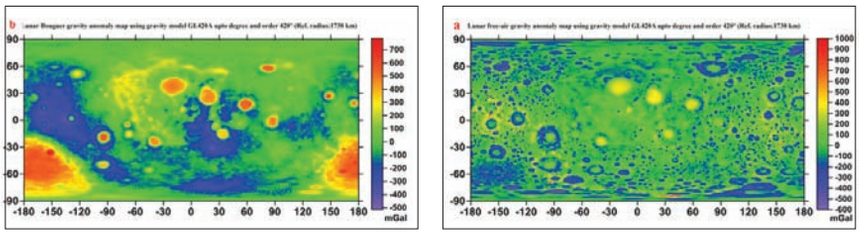


Figure a) *Free air and* ***b)*** *Bouguer gravity anomaly (uniform crustal density=2560 kg/m3) maps of Moon to spherical harmonic degree and order 420 from gravity model GL0420A.*

MOSDAC (Meteorological and Oceanographic Satellite Data Archival Centre), http://www.mosdac.gov.in:

(A) MOSDAC provided NRT data services using 50Mbps NKN (National Knowledge Network) through FTP servers to following Operational Agencies/Projects.

I. NASA-GPM (MEGHATROPIQUES – SAPHIR)
ii. NCMRWF (EUMETCAST)
iii. PRWONAM (KALPANA1, WRF Forecast, NOWCAST etc)
iv. MOM, OMM-ASIRI project (POM, SWAN and WAM model outputs)
v. For Launch Campaigns (48 hr model forecast, 30 Min forecast, next 15 days cyclone prediction, enhanced cloud images
vi. KALPANA-1 data to IMD, Delhi

(B) Weather based Information systems with email and web based alerts periodically updated for the weather events in NRT.

I. Cyclogenesis alerts with track forecasting and intensity prediction for cyclones viz. MAHASEN, PHAILIN, HELEN, MADI, LEHAR, have been released. Validation results have also been hosted.
ii. NOWCASTING results related to Heavy Rain and or Cloud Burst, at half hourly interval, on a regular basis.
iii. Sea State Forecast

(C) User centric Web Applications on MOSDAC.

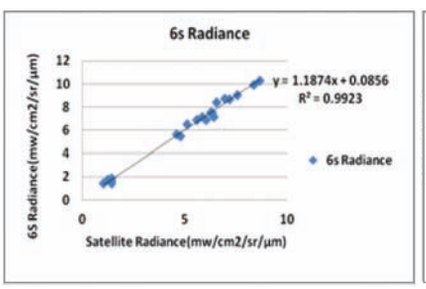
i. Web based application for generating 'OCEAN WATCH FROM SPACE'
ii. Identification and Mapping of Intense Rain over India
iii. Common map view of current position of both MEGHATROPIQUES and SARAL Satellites with 10 seconds auto refresh using MAPSERVER
iv. Orbit predictor for both MEGHATROPIQUES and SARAL Missions, to support planning of CALVAL related activities.
v. Web site for SARAL ALTIKA International Science Meet with features for registration, uploading of abstracts, online review of abstracts with automated email responses to end user.

MOSDAC USAGE - April 2013 to March 2014	
New Registrations	229
Number of hits	95,248
Data Ordered online in TB	3.6

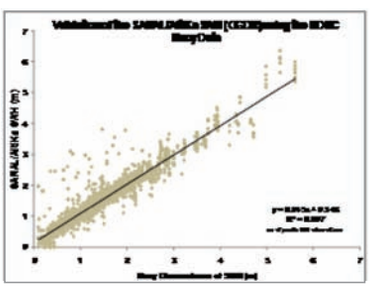
FTP download by PIs in (GB) MEGHATROPIQUES SARAL CALVAL	1105.2 770.0 3.06

(D) CALIBRATION AND VALIDATION ACTIVITIES

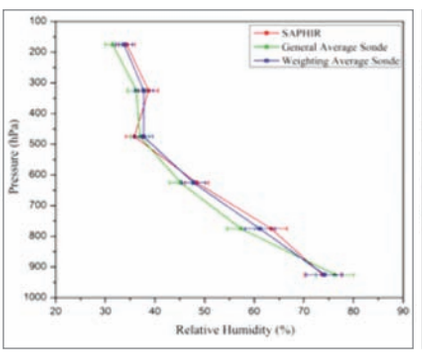
Three CAL-VAL sites at Rann-of-Kutch, SAC-Bopal and Bhopal have been developed for medium/coarse resolution, high resolution sensor calibration and Geo-physical products validation. The sites have been developed for land and atmospheric sensors e.g. Resourcesat-2, INSAT-3D, RISAT-1 and Cartosat-2. Various in-situ parameter measuring instruments were installed on three sites and made operational for regular in-situ data collection. Training was provided to participating agencies personnel for routine operation and maintenance. The fully operational Kavaratti site in Lakshadweep was utilized for OCM-2 vicarious gain coefficients generation, OCM-2 geo-physical validation, Saral



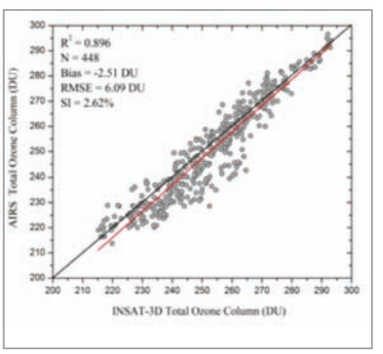
Resourcesat-2/LISS-3 Vicarious Calibration



SARAL/AltiKa SWH Validation



Portable Multimedia Terminal (PMT)



SAPHIR RH Validation

altimeter calibration/validation and Meghatropiques products validation. The development activity of a coastal KG site in Krishna-Godavari basin is continuing and a robotic SeaPRISM system for normalized water leaving measurement/validation in coastal region at Ravva JV field has been installed on an off-shore oil platform. An integrated buoy based system is being designed and developed for KG site. INSAT-3D imager vicarious calibration was carried out at Little Rann of Kutch site using synchronous experiments and Ozone products were validated. Megha-Tropiques products were validated for Madras, Saphire and ScaRaB payloads. Resourcesat-2 AWIFS, LISS-3 and LISS-4 sensors were vicariously calibrated on Rann-of-Kutch sites. RISAT-1 SAR calibration was carried out using Trihedral corner reflectors. Absolute calibration of Saral Altimeter and products validation was carried out. Kavaratti ocean site in-situ data has been archived regularly in MOSDAC.

Facilities

During the year a large number of facilities have been brought-up to cater to the future demands of the payload developments in the Centre. New technologies/process development activities in the areas of antenna, Electronic & Mechanical Services & Support have been taken up to cater the need of future payloads requirements.

Major Accomplishments under electronic and mechanical services are listed below

- MMICs design and fabrication activities: Ka-band LNA with ultra low noise (RFOW NF: 1.5dB), high gain (30dB), chip size of 3.29mm x 1.74mm and Ku band LNA with low noise (RFOW NF: 1.2dB), high gain (33dB), chip size of 2.35mm x 1.74 mm
- Design & fabrication developments of Ka to Ku down converter & Ka x S band down converter
- Q & W band MMICs and test modules for GEOSAT & remote sensing
- SAW design & development activities
- Optical fibre link between SAC and Bopal campus
- Access control system (ACS) at Peripheral gates
- Power fencing system at SAC and CCTV Surveillance

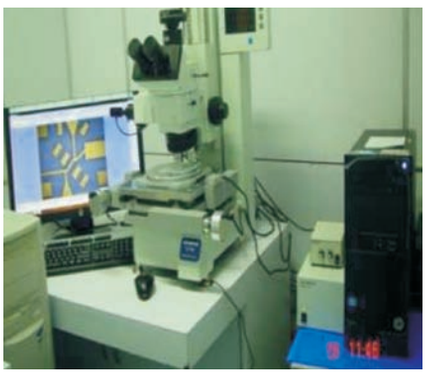
About 26 new process are developed in house and 22 new process are under development or optimization under electronic and mechanical services. 5 vendors are qualified for PCB fabrication, MLB fabrication & MMIC assembly for on-going projects.

Facility Augmentation

LTCC facility was established, process optimisation and qualification is in progress. Realisation of MLB facility is in progress. Some of the important facilities realized are

- LASER Lithography System (µPG101)
- Table Top 2KV SEM
- Direct Write Lithography (DWL) with two side patterning
- Multi Layer Press
- Inspection & Measuring Microscope (STM 6)
- Profile Projector (NIKON V-12BDC)
- DC Voltage Reference standard (calibration instrument)
- Altitude (high & low pressure), temperature and humidity test chamber
- Development of low cost hot & cold chamber using domestic fridge
- Double Decker hot chambers
- Large size bare PCB inspection system (AOI) capable of inspecting large sized laminates for patch-antenna purposes (size in excess of 1.0m x 0.75m)
- Computer controlled Inverted microscope
- Pico-ammeter, for detection of leakage in soldered feed-through in RF cavities.
- RF probing station having probing capability up to 67GHz over -40ºC to +200 ºC temperature

- NitroPlex Humidity controlled and ESD safe cabinets with sensor accuracy of ±2% RH
- Magnetically locked pass box to enhance the contamination control in BS.
- Microscope with 10M camera & Color monitor for quantity verification
- Indigenous Solder-ability tester
- XRF based Plating Thickness and composition analyzer
- Microscope of LEICA
- Surface roughness analyzer (T-6000)
- High magnification microscope



Inspection & Measuring Microscope

LASER Lithography System

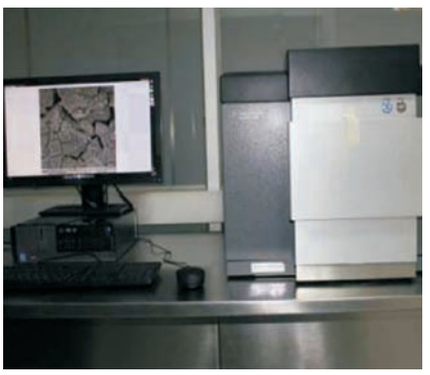
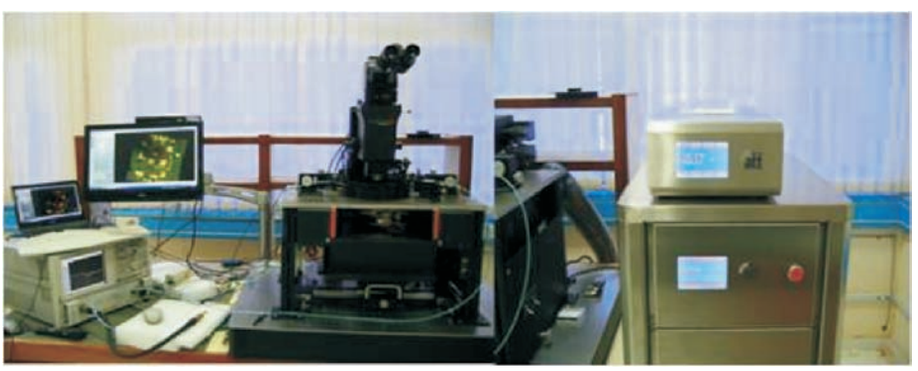


Table Top 2KV SEM

Direct Write Lithography (DWL) with two side patterning

Altitude (high & low pressure), temperature and humidity test chamber

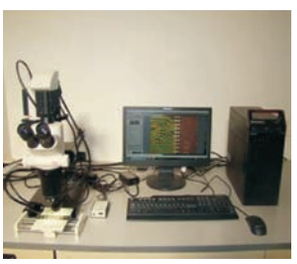
DC Voltage Reference standard



RF Probing Station

Pass box installed at Bonded Stores

Solderability Tester

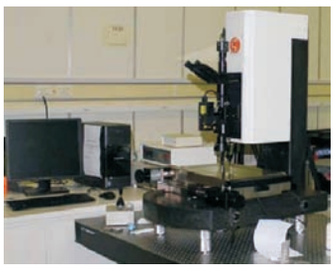


Leica Microscope

Surface roughness tester

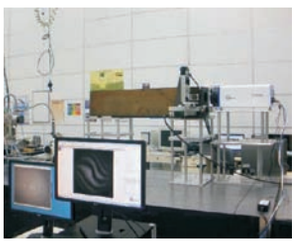
Augmentation of analysis table with reagent racks for electroplating section, Augmentation of chimney hoods for high fume generating gold plating, black anodizing and masking areas and enhancement of calibrator using AC/DC Current Amplifier are other developments in this area.

- 3 axis high accuracy, high magnification and long work distance travelling microscope for the development of detector optical butting
- QDIP lab with double stage Gifford -McMahon cryo-cooler
- Measurement of Active length and Active pixel size of CCD/CMOS image sensors
- Electro-Optic characterization Test bench for 1.3K QUAD TDI CCDs
- 4D Interferometer for characterizing the focal plane of a scene simulator
- Vertical Machining Centres
- Micro Tapping Machine
- Co-ordinate Measuring Machine
- Vision Measurement System
- Close Range Photogrammetry (CRP)
- Automation of Antenna Measurement using Laser tracker



long distance travelling microscope

Gifford -McMahon cryo-cooler



4D Interferometer

Vertical Machining Centres

Vision Measurement System

Reliability & Quality Assurance

Reliability & Quality assurance includes Reliability Engineering functions for various Space and Ground hardware developed in the centre. These encompass Quality Assurance of Electronics and Mechanical Engineering processes, Electro-chemical Materials and processes and Test & Evaluation activities. Software Quality assurance activities are also carried out for On-board, Payload Checkout and Ground Applications.

Implementation of State of the art verification methodology for FPGA Verification

State of the art verification methodology - Universal Verification Methodology (UVM) was implemented for FPGA/ ASIC design verification in a phased manner.
A TDP for 'Automation of digital VLSI design functional verification using advanced techniques and methodology' was completed successfully. This technique is being used for the verification of FPGA designs of Chandrayaan-2 and OBC ASIC-2.

Workmanship Quality Audits

In order to ensure the quality of systems fabricated, 163 Audits were carried out on facilities and fabricated hardware. A total of 189 units were cleared for T&E for various projects.

Component Screening and Procurement Support

Approximately 63,000 components were inspected and cleared for QM/FM subsystems. This includes more than 2,000 bare die of different functionality, which were inspected for in-house developed hermetically sealed ALC DAs.

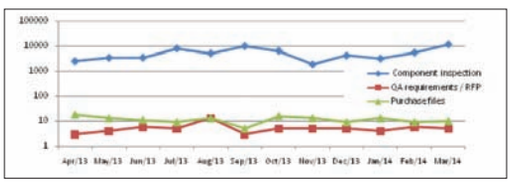


Figure Summary Chart for Inspection and QA activities of component procurement

Overall summary of component inspection and QA activities of FM procurement is represented in the following chart:

Test and Evaluation Activities

Test & Evaluation of 217 subsystems and 9 integrated payloads of communication, remote sensing & navigation satellites was completed. In addition, revalidation/ acceptance testing of 65 procured subsystems and EMI/EMC testing of 230 subsystems of communication, remote sensing & navigation payloads was carried out.

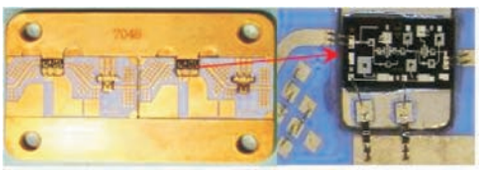
Process Qualification

The area carried out the qualification of a 31 new processes for Electronic fabrication (19), Mechanical fabrication/ Surface treatment (10) and assembly of Optical elements (2) for use in payloads.

Some of the new process qualified activities carried out are listed below:

- Pattern Generation Process (Single Process) on RF laminates
- MIC Fabrication Processes on Alumina Substrates
- 10-Layer MLB from Vendor, Ms. Hi-Q Electronics – Hosur
- MMIC Assembly and Wiring Process at Vendor, Ms. KAL – Ahmedabad

10 layer MLB

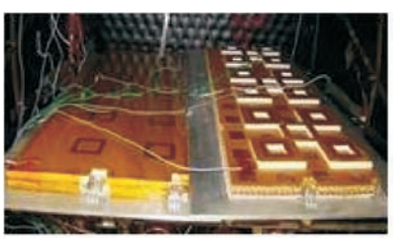


MMIC Assembly and Wiring

- Dual Sided PFT and Si-Die Assembly Process on Carrier-Plate at Vendor, Ms. CEL – Bengaluru
- Assembly and Wiring In-house Process for interconnections from PFT to Multi-pin Connectors and RF Feed-throughs.
- Hermetic Sealing of RF packages at M/s AMPL – Hyderabad

In House Qualification testing completed for following processes:

- Gold Plating on controlled expansion alloys (AL-Si) CE-7.
- Gold plating on Kovar, SS-304 and Silver
- In-house developed TIG welding process on aluminum alloy along with clearance of PID
- Qualified the clinching process
- Chandrayaan–II SAR Antenna Adhesive Bonding Process
- MX filter mount bonding assembly using sand blasting on INVAR mount. Total 100 nos. of filter bonding assembly done by vendor using SAC facilities. Sand Blasting over INVAR mount is suggested to improve the Adhesive bonding strength.

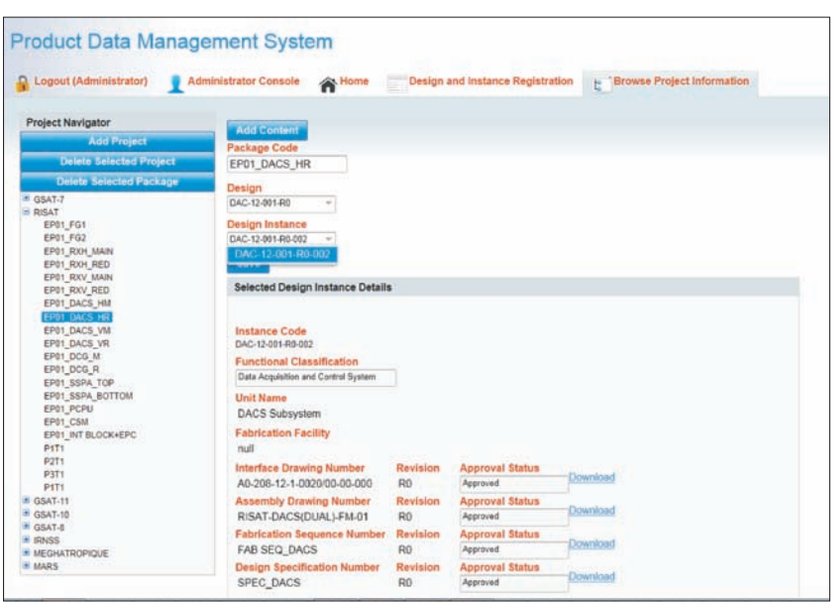


Adhesive bonding process qualification

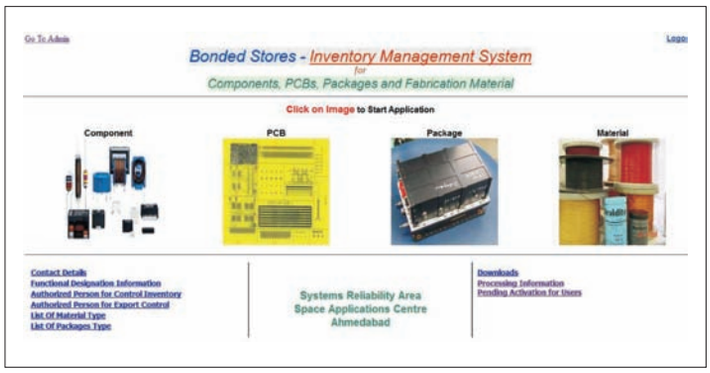
Tig welded sample

Product Data Management System

In order to provide unique identification to all mechanical hardware fabricated and to establish complete forward and backward traceability with the final sub-system, QACMG had devised a hierarchal identification system. OSQAD has developed and operationalized the software application for the same. This PDMS is implemented in the SRA record management system, and provides a database linking each drawing to all fabricated units; and will ensure hardware traceability for payloads.



Bonded Stores



Updated Component Information Management System software installed with features like assigning location of component, single login password, material and packages have been maintained separately, repeat of SIV (from old to new), reservation of components, auto cancellation of voucher and auto email after processing of vouchers etc. The physical verification of the component stock in the Bonded Stores at SAC was completed and final report on "Verification of the Component Stock in the Bonded Stores," Report No. SAC/SRA/BS AUD-01/2013, February 2013 was prepared.

8, 97,775components, PCBs and Material were handled under receipt, sorting, binning, delivery, and stock-keeping for Geosat, IRNSS and Remote Sensing (Optical and Microwave) payloads through a comprehensive software access control.

Automated Test Setup for T&E Activities

Automated setup was developed for simultaneous testing of multiple on-board sub-systems. This has helped increase the throughput of testing and repeatability of measurements.

Automated T&E Setup Screenshots

Development and Deployment of SQA tools

- Microcontroller software test framework for testing complex data, interrupt and timing functions for on-board software was developed and successfully demonstrated by testing partial functionality of software of DMSAR PLC. This framework was re-factored to support parallel running test threads.
- GSQAD developed and deployed packages and software tools to enable SQA for ground applications. These are

(I) Centralized Quality Assurance Portal

(ii) Project Portal infrastructure for content and knowledge sharing for multiple intra-centre projects and

(iii) Internal Software Asset Management System (i-SAM).

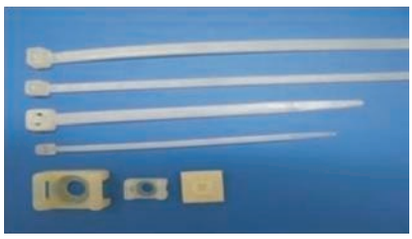
इसरो ISRO
अंतरिक्ष उपयोग केंद्र (इसरो), अहमदाबाद
वार्षिक रिसपांड समीक्षा
Space Applications Centre (ISRO), Ahmedabad
Annual Respond Review

Research & Development and Indigenisation

During the year about 134 TDP/R&D activities are going on in the Centre. Some of them are mentioned below:

- Data Acquisition, control and monitoring system for UAV based EO sensors
- Turbo coded Spectral efficient APSK Modulation for future communication satellites
- High Speed 16 – bit LVDS Serializer – Deserializer (500 MBPS to 1.5 GBPS)
- Digitally Controlled Switch Mode Power Supply
- Study and Simulation of Long Code Acquisition Techniques for GNSS
- Design, Simulation and prototyping of Carrier Cancellation Technique for Efficient spectrum utilization
- Study & design of generic front end for IDU of SATCOM terminal and Feasibility study for mixed signal ASIC development
- Digital ASIC for configuration of miniaturized CMOS camera module
- ASIC for Programmable Bias Generator for Detectors
- CCSDS “Space Packet Protocol” Development for Configurable Data Formatting System
- High Resolution (14-16) Medium Speed 5 Msps, Low Power ADC for ROIC
- Scanning Mechanism and its control for laser altimeter evaluation
- DSP Based Re-configurable Real Time Payload Data Processing System (DPS)
- L&S-Band air Borne SAR
- MinSAR:X Band Airborne SAR
- Rapidly Deployable Multi-band VSAT Terminal for Disaster Management
- Development of Packaged X band RF MEMS SPST and SPDT Switch Module
- Antenna System for Dual Frequency (C/Ku) Pencil Beam Scanning Scatterometer
- Feasibility of Tunable Antenna using Barium Strontium Titanate (BST) BaxSi1-xTiO3 thin films
- Quiet Zone Performance Analysis and Error Estimation in Antenna Test Range
- Pre-Compensated Reflector Shaping
- Single Calibrator Source (VIS to TIR)
- Micro-lens array, Origami & Hybrid Lens
- Quantum Dot Infrared Photo-detector (IITB)
- Development and fabrication of thin film integrated passive (R, C) components
- Cu alloyed Aluminum metallization for SAW devices
- Direct metallization process for high power MIC containing high current carrying thick copper traces
- Development of universal Drivers for EEV for Energy Conservation
- Nano fluid based Heat Pipe Development
- Convective heat transfer studies in low atmospheric regime
- Thermal Conductivity studies of PEEK material for development of light weight reflector
- Shared Aperture Shaped Beam Antenna and Isoflux Antenna
- High Efficiency Single Aperture Single Feed per Beam type Multiple Beam Antenna
- Quasi-optical MMW Antenna System
- Tunable Antenna using Barium Strontium Titanate (BST) BaxSr1-xTiO3 Thin Films
- Antenna System for Dual Frequency Scatterometer at C & Ku band

Indigenisation

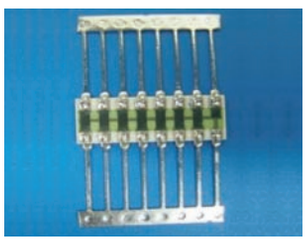


Cable Ties and Mount

During the year qualification of OCXOs, 13 types of cable ties and 3 types of tie-mounts has been completed. VOQ of Indigenous TCXOs has also been completed and validity of qualification increased for 3 years. Additionally, IIPAC cell was instrumental in establishing a rate contract of OCXOs for GEOSAT Satellites.

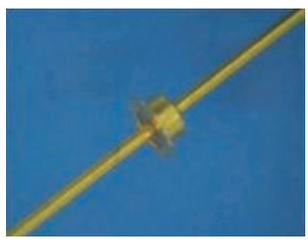
PDR of Crystal filter completed. Mechanical package design, layouts, schematic have been reviewed by PRT/SCRC and DVM completed. Optimizations of electrical parameters are under progress. Screening test and Qualification test of Resistor Network (Flat pack and DIL) at vendor's place has been completed. Tests like Thermo vacuum, Vibration, etc. are under progress at SAC. Qualification activity of capacitor Feed through Filter is being started. Audit and pre-cap of SFT Header completed. Screening tests are nearer to completion. Qualification testing will be started soon.

Crystal Filter



Resistor Network

Capacitor Feed-through filter

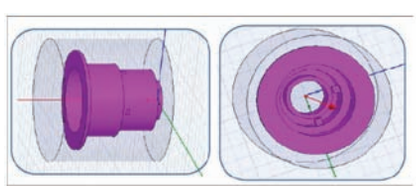


SFT Heater

RESPOND

Research and Technology Development Programs form an important part of any research organization. The in-house research can be taken up under TDP/R&D Activities and the research projects can also be taken up at academic institute under RESPOND program of ISRO.

- A compilation of all research papers taken under TDP/R&D, Respond and Projects, "A Compendium of Research Papers prepared during year 2013" was released in January 2014. The Ongoing research projects of RESPOND are reviewed in Annual RESPOND Review at SAC. In this year Annual Respond review was held in December 12-13, 2014. 47 principal investigators / representatives from academic institutes & universities participated. 12 projects were completed during Jan 2013 to Mar 2014. 36 projects are on-going as on March 2014 and 8 new proposals were reviewed. Evaluation of 22 completed projects was carried out and outcome from 22 completed projects is
  - Total papers published: 123
  - Methodology/ Techniques delivered: 2
  - Algorithms/ Software developed: 11
  - Model developed: 2



Analysis and development of Matched Feed for offset parabolic antenna system : Triple Mode Horn: Design

With the proactive approach for research solicitation, nine interest exploration meetings were held at various geographical locations of the country. The Interest Exploration meeting was organized on Sponsored Research (RESPOND) programme of ISRO for academic institutions of Gujarat on 31 January 2014 in Tele Education mode from studio at BISAG, Gandhinagar through INSAT-4CR satellite. 42 Government Engineering Colleges of Gujarat participated in two way video and one way audio mode. With this proactive approach for research solicitation, "Sponsored Research (RESPOND) at SAC" internet

website www.sac.gov.in/respond is also developed and updated regularly which is widely used by PIs of new proposals and ongoing projects.

A MOU was signed with Charotar University of science and technology on February 2014 for Joint development of experimental instruments and associated test software and hardware to be flown on Indian Spacecraft. The total fund released during the year 2013-14 for “RESPOND at SAC” is Rs. 76.38 lakhs.

Management Support Activities

In order to achieve organizational goals, all activities needs to be synergized and management unit act as a backborne for all the activities. Throughout the year a large number of backbone activities take place in the Managerial systems which make the environments conducive for the realization of Research, development & project activities in the Centre. These activities are channelized through Projects & Planning Group.

Projects and Progress Monitoring

Progress monitoring of various ongoing projects in the Centre, independently and through various committees, assessing and coordinating the resource requirements, identifying critical areas and generating follow-up action items are crucial activities to keep the projects on track. In order to evolve an effective Project Monitoring mechanism in the centre, a compilation of the scheduled activities and sub-tasks of all the projects and TDP activities of the centre are carried out. Monthly progress & status of the Centre is generated every month from the inputs of the Divisions/Groups and Areas in the Centre and a highlight of the activities is sent to Head quarters. An Archival of the monthly progress reported by various division, groups and areas is being maintained.

In order to have comprehensive and independent project monitoring a Collaborative Intra centre Review Mechanism is implemented through committees as mentioned below;

1. Communication & Navigation Systems Monitoring and Review Committee (CNMRC)
2. Remote Sensing Sensors Monitoring & Review Committee (RMRC)
3. Applications Projects - Monitoring and Review Committee

These Committees are responsible for monitoring the status and progress of on-going activities/projects in the respective areas and helping the project functionaries. They enable inter-entity coordination and help to identify the critical areas of the project.

A detailed compilation of the centre's activities was carried out and the Annual Report of the Centre for the year 2012 – 2013 was generated. Periodical reviews of several ongoing projects by Director, SAC were arranged. Problem areas were highlighted during the review and action items generated were followed for timely resolutions.

Results Framework Document (RFD)

RFD is an important tool for the monitoring and evaluation of the various on-going activities/projects in the centre. The Prime Minister approved the outline of a 'Performance Monitoring & Evaluation System (PMES)' for Govt. Departments. Under PMES each department is required to prepare a Result-Framework Document (RFD). RFD provides a summary of the most important results that a dept/ministry expects to achieve during the financial year. The main purpose is to provide an objective &

fair basis to evaluate department's overall performance at the end of the year. 9 activities were completed out of 11 identified activities and score of 3.03 pts out of 4.0 pts was achieved for the year 2013-14.

Budget Planning & Monitoring

Overall budget of the centre is monitored through regular expenditure reviews with purchase, account and Budget Coordinator to realize the targeted spendability. Centre budget expenditure was depicting the smooth and well planned operation of the centre where spending of the total annual budget was 26.33% in first quarter, 29.60% in second quarter, 25.07% in third quarter and 18.97% in fourth quarter.

In addition to this, during the year Spendability analysis, Preparation of inputs for performance budget document, Re-conciliation of budget proposals with HQ guidelines, Re-conciliation of budget proposals vis-à-vis the approvals from ISRO council, Preparation of operation budget document through COWAA Finance Module were prepared.

Human resource development (HRD) activities

Human resource development activities at SAC is doing its key role in the process of developing human resources through its comprehensive training plan and also by creating new learning platforms. 14 in-house programmes were designed and organized during 2013-14 that accommodated 468 participants. This includes an Executive Development Programme (EDP) and a Structured Training Programme (STP) for ISRO level participants. Besides, SAC organized 4 open-house seminars on various themes during 2013-14. For the benefit of administrative staff, a training programme was organised on administrative topics in association with Institute of Secretariat Training and Management (ISTM), New Delhi. About 107papers were presented by Scientists/Engineers in various Conferences/Symposiums/et al. 60 higher-studies cases were also recommended during 2013-14. Human Resource Development Division (HRDD) has organized 9 lectures under Knowledge Sharing Series and 20 lectures under SAC Lecture Series. Under the guidance of Director-SAC, a new series- “Know Your Achievements (KYA)” has been instituted in 2013 with an objective to felicitate project executives of successful missions. We organized 4 events under this platform during 2013-14. In-plant training has been recrystallized with brand name SAC: Academic Associate Programme (SAC-AAP) with three categories of Internship.

Capacity Building

SAC is actively involved in conducting UN sponsored technical courses for students of different developing countries in the Asia Pacific region. The Valedictory function of Satellite Meteorology and Global Climate (SATMET-8) course of Centre for Space Science and Technology Education in Asia and the Pacific (CSSTEAP) was organized at SAC, Bopal campus on April 29, 2013. Padma shri Prof. P P Kale, Former Director, SAC was the chief guest for the occasion . He distributed the P.G diploma certificates to all the fourteen participants and also delivered the valedictory address. He advised the students to be the ambassadors for promoting CSSTEAP activities so that more people get benefited out of it.

SATNAV is one month course on satellite navigation. Faculty includes in-house, retired from ISRO and external organizations. Total 16 candidates were selected from different countries from Asia-Pacific region. The NAVSAT course was completed on July 2013 and Certificates were distributed by Dr S. Kalyanaraman, Former Program Director IRS, ISRO during the Valedictory function. An Inaugural function and Orientation course for SATCOM-9 was conducted on August 2013 at Bopal Campus.

Centre for Space Science & Technology Education in Asia and the Pacific
(AFFILIATED TO UNITED NATIONS)
Valedictory Function
SATELLITE METEOROLOGY & GLOBAL CLIMATE – 8
&
SPACE AND ATMOSPHERIC SCIENCES – 8
April 29, 2013
Space Applications Centre, Bopal Campus, Ahmedabad

Valedictory function of SATMET-8 course on April 29, 2013

Intellectual Property Rights & Technology Transfer

ISRO HQ has granted approval for three technologies (Precision Tapping Mechanism, Solid State Power Amplifier and PI Box). A brochure for announcing e-System for Mechanical Workflow-management And Reporting Tool (e-SMART) software product was prepared for ToT.

During the year One patent (A Method for Simultaneously Generating Pencil Beam and Shaped Beam from a Singlr Shaped Reflector - No. 257011 Dt. 26/8/2013) was granted and two patents were filed. Three patents were approved by centre Director and sent to ISRO HQ for further process. One copyright was approved by centre Director and sent to ISRO HQ for further process.

Technical consultancy on development of 'Burst Demodulator' was given to M/s Komoline Aerospace Ltd, Ahmedabad and Design consultancy of 'Shaped Reflector Antenna' was given to M/s Sumeru Microwave Communication Pvt Ltd, Ahmedabad. Some of the major MOUs executed are listed as below;

- C-DAC , Pune for use of PARAM Yuva super computing facility to run the Weather Research and Forecasting (WRF) model for all India short range weather forecast
- Intelligent Communication Systems I Ltd. (ICSIL, New Delhi) for providing skilled manpower on contract basis.
- National Institute of Design, Ahmedabad for associating through design projects for User Interface Design Exhibition & Exhibits, educated programme through animation etc.
- Charusat Space Technology Centre, Charotar University of Science & Technology, Changa, Anand, joint development of technology demonstration experiments to be flown on spacecraft.
- IIT- Gandhinagar for Research Collaboration for mutual benefit.
- Noorul Islam Centre for higher education (NICHE), Kurmarcoil for joint development of optical and microwave payloads & Image data processing.
- During the year Following tests facility at SAC was utilized by various Indian industries:
- Micro-sectioning on Laser Welded units
- EMI/EMC test on MMIC based Ku Band Receiver FM unit, OCXO (for GSAT), C band MMIC Receiver (FM units)
- Outgassing test on Globtop material FP4450
- Selective Gold Plating on receiver housing
- Waveguide Assembly test by bending & TIG welding process

Network & Information Services

Information Technology and network services in SAC is maintaining all centralized network services within the Centre. It provides operational services for web applications like SAC intranet- Aakash, SAC

Website-Vyom, digital repository - Vedansh (both technical & non-technical), Transport booking, resource booking etc. It provide all technical services and support for the online antivirus application, email, FTP and internet services within the Centre.

SAC has taken lead role in using National Knowledge Network (NKN) for Inter centre data communication. NKN-VRF Network connectivity was provided for INSAT-3D Project and MARS-MOM Mission data transfer at 3 different locations. A Vehicle Parking System was released on Aakash to collect the vehicle information of all SAC employees to manage parking in the campus. A Knowledge Sharing Portal, for exploration and documentation on popular social networking sites for sharing the information in an informal way was initiated.

Manpower & Information Systems

Manpower and Information systems is responsible for Design, Development, Implementation, Operation & Maintenance of various softwares and Web Sites developed for Administrative Divisions of SAC. During the year COWAA hardware and software was upgraded (software was migrated to Fault Tolerant based hardware platform with RHEL 6.0 operating system and database was migrated from Sybase 12.0 to Sybase 15.7) as per the COWAA project guidlines.
As an enhancement to the existing manual lunch booking system 'Akshaypatra' a new feature of "Tatkal" Booking, E-mail based booking and complete automation & removal of Tea/Coffee coupon was introduced. In order to maintain and control the CHSS Medical Reimbursement supplementary payments, a software 'CHSS Supplementary Payment Control System'' was implemented. Automation in Recruitment Process (ARP), a software for the recruitment process of the candidate was operationalized. Reports like attendance sheet, call letter, TA payment list etc can be generated from the system. The online data captured by the OSAR system is directly migrated to ARP system and further processing can be done. Additional features are added to the '*कोवा हिंदी प्रणाली*'. A Web based software for SIV preparation using COWAA database was developed, in which an employee can generate a request for SIV preparation and will be registered by his/her division head. The request gets captured in the COWAA database.
During the year, 'CL Work Flow Application (CLWA)', a web based application to enable an employee to apply/recommend/approve/cancel/withdraw online Casual Leave was fully implemented within the Centre. SAC-DigiSign software was developed in-house, is a move towards the vision of a paperless office and is being used by all the employees and various applications developed in SAC for the purpose of digitally signing the documents. As per the mandate by Department of Space, Electronic Government Procurement System (EGPS) is implemented by all ISRO Centres/Units. A website has been designed, developed and implemented as value addition to EGPS for various MIS purposes. A system was designed to take print of Annual Performance Assessment Report (APAR) for all the regular employees of SAC and DECU. It provides facility to print APAR both division wise and also for an individual.

Space Exhibition (VSSE)

About 10 mobile exhibitions arranged at various locations in Gujarat, Goa and Rajasthan. National Science Day (Feb. 28) and National Technology Day (May 11) were celebrated. Models of Mars colour camera (MCC) and Thermal Imaging Spectrometer (TIS) of MARS Mission, indigenous TTA and TR modules were displayed during the exhibitions in VSSE. VSSE had participated and established a exhibition, during the "Astro Youth Fiesta-2014" organized by Genius Group of Institutes at Rajkot, where more than 400,000 persons visited and the event was covered by all leading print and TV media.

Library

Considering the users preference of electronic access, during the year 2013-14, SAC library added 2919 titles of news clips, e-books, e-reports and papers of SAC scientists, published in various journals, thesis and e-issues of In House publications such as “SAC Courier” and Hindi magazine “Abhivyakti” in its digital repository. Approximately 200 ISRO reports were also inhouse digitized and archived.

During the year, library procured, technically processed (Cataloguing, Classification and Display) about 170 books/monographs and 475 other types of documents which include technical reports, standards & specifications, Hindi books and other miscellaneous documents.

During 2013-14, 124 CD/DVDs were mirrored and linked with the Libsys database along with 2203 previously mirrored CDs/DVDs for their access through OPAC.

SAC library renewed its subscription of SPIE E-books (approx 200 titles), and 551 various e-journals from major publishers such as IEEE/IET, Springer, Science Direct, John Wiley, Taylor & Francis, SPIE, AMS, AIP, OSA etc, providing full text access using internet from SAC's main,
Bopal as well as DES Campuses.

Subscriptions for 5 new periodicals, namely, Journal of Scientific Temper (Print); GPS Solutions (Print and Online), ACM Computing Surveys (Online only), Construction Week India (Print) and Construction World (Online only) were started during the period. Total 3981 loose issues of the subscribed periodicals and 4514 Issues of newspapers were registered during the period.

This year library extended 371 permanent (Regular Employees) and temporary (Student Trainees, Apprentices, JRFs etc) memberships. more than 328 out of total 405 requests for articles on Inter Library Loan from / to various libraries were fulfilled. 72 books and monographs were exchanged on ILL with various cooperating libraries. In reprographic facility of SAC Library, approx. 11,31,064 pages were printed out of which 47% were in B&W and 53% pages in colour for 418 documents like PDR, DDR, reports, scientific documents, articles, Hindi books and magazines. Approx 4,318 documents were bounded in-house.

Following are the new facilities established

- Configuration of new server for library digital repository and installation of Dspace 3.1.2.
- Installation of Open source Library automation software - KOHA (an open source library management software) for SIPA, Bopal Campus and DES Library at New Delhi along with creation of a database of books present in DES Library during 19-20 February 2014.
- A new heavy duty printing machine Konika Minolta Bizhub Pro 951 (95 ppm) with finisher was procured and installed.

VISITOR

वर्ष 2013-2014 के दौरान राजभाषा नीति के कार्यान्वयन के संबंधित सैक डेकू की विशिष्ट उपलब्धियाँ कार्यों का संक्षिप्त विवरण

उपलब्धियाँ

दिनांक ३ अप्रेल 2013 को संसदीय राजभाषा समिति की आलेख एवं साक्ष्य उप समिति ने अहमदाबाद नगर में स्थित केंद्रीय कार्यालयों में से 15 कार्यालयों के प्रधानों के साथ विचार-विमर्श कार्यक्रम आयोजित किया। अंतरिक्ष उपयोग केंद्र के निदेशक, श्री आ.सी. किरणकुमार ने कार्यक्रम में भाग लिया। माननीय उप समिति ने अंतरिक्ष उपयोग केंद्र में हो रहे राजभाषा कार्यान्वयन की खूब सराहना की। इस अवसर पर माननीय समिति सदस्यों के अवलोकनार्थ सैक की ओर से भारतीय अंतरिक्ष कार्यक्रमों पर आधारित एक प्रदर्शनी का भी आयोजन किया गया, जिसे खूब सराहा गया।

माननीय राष्ट्रपति के कर कमलों से सैक के वैज्ञानिक श्री कमलेश कुमार बराया को पत्र पत्रिकाओं में हिन्दी में उत्कृष्ट लेख हेतु वर्ष 2012-2013 के लिए तृतीय पुरष्कार प्राप्त हुआ। यह पुरस्कार 14 सितंबर, 2013 को हिन्दी दिवस के अवसर पर विज्ञान भवन, नई दिल्ली में आयोजीत समारोह के दौरान माननीय राष्ट्रपति महोदय के कर कमलों से प्रदान किया गया।

नगर राजभाषा कार्यान्वयन समिति, अहमदाबाद द्वारा अंतरिक्ष उपयोग केंद्र को राजभाषा नीति के सर्वोत्तम कार्य निष्पादन हेतु 15 जुलाई, 2013 को आयोजित नराकास की 62वीं बैठक के दौरान प्रथम पुरस्कार प्रदान किया गया।

केंद्रीय हिन्दी सचिवालय परिषद द्वारा प्रायोजित हिन्दी निबंध प्रतियोगिता में सैक के वैज्ञानिक श्री बी. एन. शर्मा तथा हिन्दी तकनीकी लेख प्रतियोगिता में श्री पुरुषोत्तम गुप्ता को पुरस्कृत किया गया। यह पुरस्कार दिल्ली में 13 अगस्त 2013 को आयोजित एक समारोह में प्रदान किए गए।

नगर राजभाषा कार्यान्वयन समिति की विविध प्रतियोगिताओं में सैक के स्टाफ सदस्यों श्री मुकेश कुमार मिश्र, श्री संगीत कुमार मिश्रा, सुश्री पूजा कक्कड एवं श्री आशिष सोनी को पुरस्कृत किया गया। ये पुरस्कार 20 दिसंबर, 2013 को आयोजित नगर राजभाषा कार्यान्वयन समिति की 63वीं बैठक के दौरान मुख्य आयकर आयुक्त के कर कमलों से विजेताओं को प्रदान किए गए।

आयोजन

अंतर केंद्र हिन्दी तकनीकी संगोष्ठी

अंतरीक्ष उपयोग केंद्र तथा विकास एवं शैक्षिक संचार यूनिट के संयुक्त तत्वावधान में दिनांक 14-15 अक्तूबर 2013 को अंतरिक्ष प्रौद्योगिकी आपदा प्रबंधन में भूमिका विषय पर दो दिवसीय अंतर केंद्र हिन्दी तकनीकी संगोष्ठी का आयोजन किया गया। कार्यक्रम की अध्यक्षता श्री आ. सी. किरण कुमार, निदेशक, सैक और मुख्य अतिथि के रूप में श्री अश्विनी कुमार (भा.प्र.से.), प्रबंधनिदेशक, गुजरात शहरी विकास कंपनी लिमिटेड, गांधीनगर उपस्थित रहे। इस संगोष्ठी में कुल 48 लेख प्रस्तुत किए गए। संगोष्ठी आयोजन समिति की अध्यक्ष श्रीमती मल्लिका महाजन थी।

Major Civil Works

A number of activities are carried out during this year. Total cost of the completed works are Rs. 885 Lakhs and plinth area is 15527.41 sqm.

Completed works

- New Canteen Building at SAC
- Extension to VIP suites at SAC
- Bopal Canteen Extension
- Cal-Val site at 39 acres SAC New Land
- Building No: 37-B for Plane Polar Near Field (PPNF) and Tapered Anechoic Chamber
- Construction Of Building for New Co-Ordinate Measuring Machine at SAC
- Infrastructure Work – Phase I at New Land at Bopal
- Extension of Central Stores at First Floor.

PPNF Building - 37-B

Extension to VIP suites at SAC guest house

Works in progress

- Payload Integration And Checkout Facility Building at 39 Acres New Bopal Campus, Sac
- Building For Mechanical Materials & Fasteners Stores (MMFS)
- Augmentation & Extension Of Existing Vikram Sarabhai Space Exhibition Building
- Renovation of SAC Guest House
- Extension At Second Floor Of Bldg. No. 21-A for (a) Feed Integration Lab (b) Cad Lab
- Annexe to IRS Clean Room Bldg. No. 47
- Passenger Lift At New Auditorium
- Modification In Room No. 5206 In Building No.52 at SAC

In addition to this there are many minor works (about 20), costing Rs 253 Lakhs are completed during this year.

Access control room near sac main gate

Renovation of building NO. 48

Administrative and Auxiliary Activities

Finance & Accounts:

Finance & Accounts Division at SAC is responsible for maintenance of sound accounting system as per departmentalization of Accounts and meeting expenditure & commitment over budget allocations with respect to centre & projects. During the F.Y. 2013-14 Rs.700 crores expenditure and Rs.700 crores cash flow were recorded under PAO, SAC.

Number of claims handled under different categories. Detailed information is given in a tabular form :

Sr. No.	Nature of Claims	Numbers
1.	CHSS	64,000
2.	TA /LTC /FTA	9,900
3.	Foreign Bills	6,000
4.	Local & Miscellaneous, Contingency /Imprest	13,000
5.	CMD Bills	1,700
6.	PF, Loans, Advances	1,550
7.	Pre- Audit	2,200
8.	Pension / Gratuity /Commutation / Family Pension/Revision of Pension	600

Weeding out of old records started in all sections & is still under progress, based on Records Retention Schedule. Accounts personnel / Officers have to participate in various committees like NAC-I & II, CFC-I & II, JPC, SPC, SOC, TWC-AMC, Negotiation, Survey &Condemnation, Tender Opening (Purchase / CMD), Transport, Uniform & Liveries, Recruitment & Review, CHSS, Canteens committees etc., which requires considerable amount of time and taken care of very efficiently and effectively.

Submission of consolidated monthly Accounts, consisting of "Receipts and Payment" to Chief Controller of Accounts w.r.t. Demand for Grant is one of the major work as per Departmentalization of Accounts.

Administration & Establishment

During the year 86 new recruitments (including JRF) have taken place in the centre. At the same time 81 staff members have superannuated and about 8 members have opted for VRS/Resignation during the year.

Personal files of all the employees (1851 employees, 138 apprentices and 24 JRFs) are maintained by the Establishment Section. During the year, 302 employees of various levels were given promotion to higher grades. 738 cases of LTC advances were processed and sanctioned/settled. During the year 96 cases for grant of pension/retirement benefits and a total of 476 cases of loans and advances were processed.

Purchase and Stores

- During this year, about 1362 orders for Rs. 238.65crores have been released in purchase. Some of the major orders released are given below. 338 Customs consignments have been received. In EGPS, 63 Purchase orders of value Rs. 4.71 Crores were issued and 88 Indents with estimated value of Rs. 81.86 Crores have been received in Purchase and being processed. Some of the major orders released are:

- Electrodynamic Shaker System: Rs12.02Crores
- Thermal Infrared (TIR) IDCA: Rs.53.41 Crores
- Turnkey Solution for SACNET email Server: Rs.1.87Crores
- Supply & Commissioning of PLASIV system: Rs 14.07 Crores
- Biometric Access Control System: Rs.2.68 Crores
- Ka-Band Channel Amplifiers: Rs. 7.00 Crores.

In Stores, 1277 Consignments were received during the year. 1831 SRVs were generated. Transportation was arranged for 6 payloads/consignments to ISAC. (IRNSS 1C, IRNSS 1D, IRNSS 1D Antenna, DGR Antenna of GSAT 6, 2M Unfurlable Antenna). 75 Tonnes scrap was disposed and revenue of Rs 17.27 Lakhs was generated. 25 discrepancies were closed.

Events

- SAC observed Fire Service Week during April 14 to 20, 2013. Programmes like Fire Mock Drill, Basic Fire Fighting Training and lectures were organized by CISF, Fire Wing during this occasion.

- Indian Society of Geomatics- Ahmedabad Chapter organized a lecture on 'Earthquake Research: Advancement and Challenges' on April 22, 2013 by Dr. B K Rastogi, Director General, Institute of Seismological Research, Dept. of Science & Technology, Govt. of Gujarat, Gandhinagar in the eve of 'World earth day celebrations'.

- Mr. Charles F. Bolden Jr., Administrator of National Aeronautics and Space Administration (NASA) of United States, visited SAC on June 25, 2013 to discuss the on-going cooperative activities between ISRO and NASA and the potential areas of future cooperation. On this occasion he delivered a talk on 'NASA's Space Programme' highlighting the current work and future plans like activities on asteroids.

- Independence Day was celebrated in SAC and Director, SAC unfurled the National flag. On this occasion Director, SAC inaugurated the new canteen building.

- SAC observed "Vigilance Awareness Week" from October 28, 2013 onwards. The main theme was “Promoting Good Governance - Positive Contribution of Vigilance".

- A Mini Marathon was organized within SAC Campus on 22 January 2014.

- 65th Republic Day was celebrated in SAC campus, Director, SAC unfurled the National Flag. The meritorious students of SAC & DECU community who had topped in X & XII Board exams were awarded by Director, SAC.

- On the eve of the Republic Day, the Government announced, Shri A S Kiran Kumar, Director, SAC, as one of the recipients of the prestigious 'Padma Shri' Award.

- Indian Society of Remote Sensing – Ahmedabad Chapter (ISRS–AC) arranged Prof P R Pisharoty Memorial Lecture by Shri A S Kiran Kumar, Director, SAC on ' Evolution of ISRO's Earth Observation Programme' on February 20, 2014. On this Occasion Director, SAC was felicitated for receiving Padma Shri Award.

- A function was arranged to felicitate Shri A S Kiran Kumar, Director, SAC, as one of the recipients of the prestigious 'Padma Shri' Award for his significant contribution in the field of Indian Space programme. On this occasion an educational visit for merit students of class 10-12 science stream was arranged.

- National Safety Week celebrated during March 4 - 10, 2014. Activities like Essay Competitions, Mock Fire Drill Competition, Poster Painting Competition, Elocution Competition and Safety Movie Screening was conducted on this occasion.

- SAC celebrated International Women's day on March 7, 2014. Ms. D. Thara, CEA-AUDA was the invited guest.

Publications

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Awards & Honours

- Shri. Sharad Shukla & Shri. Ravi Rama Rao of STPD received ISRO Team Excellence award 2011 for development of Ku-band Dielectric based IMUX of GSAT - 8.

- Shri S. M. Chauhan, EQCD/ESSA has been awarded with ISRO Team Excellence Award-2010 for Indigenous Design & Development of Single Aperture Multiband Multi-Polarization Multimode Tracking cum six ports Communication Feed System in Ku/DBS band and High Efficiency L1 & L5 Tapered Printed helical Array Antenna for GAGAN Payload.

- Shri Yauvan Dave and Shri A V Pathak had received the prestigious Team Excellence Award-2011 (Declared now) for the pioneering work in the field of "Development of Ku DR Input Multiplexer for Space Application".

- Shri Harish Seth (SSD/EOSG) awarded with second prize for paper presentation in "NATIONAL SYMPOSIUM ON REMOTE SENSING AND GIS FOR ENVIRONMENT."

- Certificate of Appreciation –Hari Shankar Gupta, VLSI Design 2014

- Shri U S H Rao, Sci/Eng, SEDA,SAC, receiving memento from Dr. K. Radhakrishnan, Chairman, ISRO for his paper (Co-authors : R.M. Parmar, Sandip Paul, Ankur Jain, M.M. Karimi, Siddesh Botadra) on "Camera Electronics for Thermal Detectors" at a scientific research seminar for SC/ST Scientists held at VSSC.

- Purushottam Gupta received National award (second rank) in all India competition on technical paper writing on science and technology on Technical paper entitled *कृत्रिमउपग्रहों का संरचनात्मक अभिकल्पन* , (structural design of artificial satellites), by central secretariat Hindi Parishad.

- Shri B.N. Sharma (EOPID / EOSG) is awarded third prize in All India Hindi Essay competition organised by Kendriya sachivalaya hindi parishad.

- SAC won 5 awards in various category (shown below) organized by Gujarat Horticulture Association, Ahmedabad for the year 2013

  1. 1st Prize for SAC campus in Garden category of Public sector
  2. 1st Prize for New SAC campus for educational Institutional category
  3. 1st Prize for cut flowers
  4. 1st Prize for Rose flowers
  5. 1st Prize for overall performance

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